



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al.  
Serial No.: 10/594,260  
Filed: September 25, 2006  
International Application No. PCT/GB05/01087  
I.A. Filing Date: March 22, 2005  
Docket No.: M04B101

Title: GEAR ASSEMBLY

Mail Stop Petitions  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**CERTIFICATE OF MAILING**

I hereby certify that this correspondence and every writing referred to herein as being enclosed is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on October 26, 2007.  
(Date)

Betty Lee  
Printed name of person signing this certificate

Betty Lee  
Signature of person mailing

Sir:

**PETITION FOR FILING UNDER 37 C.F.R. § 1.47(a)**

The applicant(s) hereby respectfully petition(s) the Commissioner of Patents and Trademarks to accept the filing of the above-identified application by other than all of the joint inventors in accordance with the provisions of 37 C.F.R. § 1.47(a).

Attached hereto is: (a) a declaration of joint inventor(s) John Cambridge Smith on his (or her) own behalf and on behalf of the omitted inventor(s); and (b) a statement of facts in support of filing on behalf of the omitted inventor(s).

The name, address and citizenship of the joint inventor who refuses to execute the application or cannot be reached is as follows:

Full name: Tristan Richard Ghislain Davenne

Citizenship: United Kingdom

Residence address: 15 CHAPEL ROAD  
EPPING  
ESSEX  
CM16 5DS


Country of residence: United Kingdom

The Commissioner is hereby authorized to charge to Deposit Account No. 50-4244, the \$200.00 fee required under 37 CFR 1.17(g).

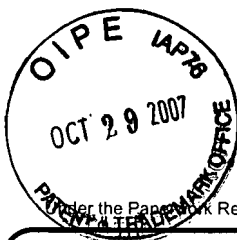
The Commissioner is requested to grant any necessary extension of time and is authorized to charge any additional fee, if required, to our Deposit Account No. 50-4244. This request is submitted **in triplicate**.

Respectfully submitted,

Date: 10/26/07  
Edwards Vacuum, Inc.  
Legal Services-Intellectual Property  
55 Madison Avenue, Suite 400  
Morristown, NJ 07960

  
\_\_\_\_\_  
Mary K. Nicholes  
Reg. No. 56,238  
Patent Agent for Applicant(s)  
(973) 285-3309

Customer No. 71134



PTO/SB/17p (10-07)  
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**PETITION FEE**  
**Under 37 CFR 1.17(f), (g) & (h)**  
**TRANSMITTAL**  
(Fees are subject to annual revision)

Send completed form to: Commissioner for Patents  
P.O. Box 1450, Alexandria, VA 22313-1450

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

Enclosed is a petition filed under 37 CFR § 1.47 that requires a processing fee (37 CFR 1.17(f), (g), or (h)). Payment of \$ 200.00 is enclosed.

This form should be included with the above-mentioned petition and faxed or mailed to the Office using the appropriate Mail Stop (e.g., Mail Stop Petition), if applicable. For transmittal of processing fees under 37 CFR 1.17(i), see form PTO/SB/17i.

**Payment of Fees** (small entity amounts are NOT available for the petition fees)

☒ The Commissioner is hereby authorized to charge the following fees to Deposit Account No. 50-4244:  
☒ petition fee under 37 CFR 1.17(f), (g) or (h) ☒ any deficiency of fees and credit of any overpayments  
Enclose a duplicative copy of this form for fee processing.

☐ Check in the amount of \$ \_\_\_\_\_ is enclosed.

☐ Payment by credit card (Form PTO-2038 or equivalent enclosed). Do not provide credit card information on this form.

**Petition Fees under 37 CFR 1.17(f): Fee \$400 Fee Code 1462**

For petitions filed under:

- § 1.36(a) - for revocation of a power of attorney by fewer than all applicants
- § 1.53(e) - to accord a filing date.
- § 1.57(a) - to accord a filing date.
- § 1.182 - for decision on a question not specifically provided for.
- § 1.183 - to suspend the rules.
- § 1.378(e) - for reconsideration of decision on petition refusing to accept delayed payment of maintenance fee in an expired patent.
- § 1.741(b) - to accord a filing date to an application under § 1.740 for extension of a patent term.

**Petition Fees under 37 CFR 1.17(g): Fee \$200 Fee Code 1463**

For petitions filed under:

- § 1.12 - for access to an assignment record.
- § 1.14 - for access to an application.
- § 1.47 - for filing by other than all the inventors or a person not the inventor.
- § 1.59 - for expungement of information.
- § 1.103(a) - to suspend action in an application.
- § 1.136(b) - for review of a request for extension of time when the provisions of section 1.136(a) are not available.
- § 1.295 - for review of refusal to publish a statutory invention registration.
- § 1.296 - to withdraw a request for publication of a statutory invention registration filed on or after the date the notice of intent to publish issued.
- § 1.377 - for review of decision refusing to accept and record payment of a maintenance fee filed prior to expiration of a patent.
- § 1.550(c) - for patent owner requests for extension of time in ex parte reexamination proceedings.
- § 1.956 - for patent owner requests for extension of time in inter partes reexamination proceedings.
- § 5.12 - for expedited handling of a foreign filing license.
- § 5.15 - for changing the scope of a license.
- § 5.25 - for retroactive license.

**Petition Fees under 37 CFR 1.17(h): Fee \$130 Fee Code 1464**

For petitions filed under:

- § 1.19(g) - to request documents in a form other than that provided in this part.
- § 1.84 - for accepting color drawings or photographs.
- § 1.91 - for entry of a model or exhibit.
- § 1.102(d) - to make an application special.
- § 1.138(c) - to expressly abandon an application to avoid publication.
- § 1.313 - to withdraw an application from issue.
- § 1.314 - to defer issuance of a patent.

  
Signature

Mary K. Nicholes

Typed or printed name

10/26/07  
Date

56,238

Registration No., if applicable

This collection of information is required by 37 CFR 1.17. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 5 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Applicant(s):** Davenne et al.

**Attorney Docket:** M04B101

**App. No.:** PCT/GB2005/001087

**National Stage Appln No.** 10/594,260

**I.A. Filing Date:** March 22, 2005

**Priority Date:** March 26, 2004

**Title:** GEAR ASSEMBLY

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**CERTIFICATE OF MAILING**

I hereby certify that this correspondence and every writing referred to herein as being enclosed is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on October 26, 2007.  
(Date)

Betty Lee

Printed name of person signing this certificate

*Betty Lee*

Signature of person mailing

**STATEMENT OF FACTS IN SUPPORT OF FILING**  
**ON BEHALF OF NONSIGNING INVENTOR (37 C.F.R. § 1.47)**

This statement is made as to the facts that are relied upon to establish the diligent effort made to secure the execution of the declaration by the nonsigning inventor for the above-identified patent application. This statement is being made by the available person having first-hand knowledge of the facts recited herein.

**Last Known Address of the Nonsigning Inventor**Tristan Richard Ghislain Davenne

Full Name of Nonsigning Inventor

15 Chapel Road, Epping, Essex, CM16 5DS, United Kingdom

Last Known Address of Nonsigning Inventor

**Details of Efforts to Reach Nonsigning Inventor**

On August 30, 2007, I sent Mr. Tristan Richard Ghislain Davenne the attached letter dated August 28, 2007 which was sent to him by courier (i.e. DHL No. 7407809743) together with a copy of patent application serial number 10/594,260, filed September 25, 2006, entitled Gear Assembly. Also enclosed with the letter were an inventor's Declaration form, an Assignment form, and a Power of Attorney form for his review and execution. A copy of the August 28, 2007 letter, patent application, and forms as sent to Mr. Davenne are attached. I sent the letter to Mr. Davenne's last known address at the time. Thereafter I learned that Mr. Davenne had moved as shown in the attached tracking history for DHL No. 7407809743, the entry entitled "9/3/2007 10:18 am."

On September 25, 2007, I obtained from my assistant, Ms. Betty Lee, a more recent address for Mr. Davenne provided by Ms. Julia Tribe, the Intellectual Property Formalities Administrator of Edwards, Ltd. (formerly the The BOC Group, plc and The Linde Group and parent of Edwards Vacuum, Inc.) in the United Kingdom. A copy of the September 25, 2007 email is attached.

On October 9, 2007, I sent Mr. Davenne the attached letter dated October 9, 2007 which was sent to him by courier (i.e. DHL No. 7407809953) together with a copy of patent application serial number 10/594,260, filed September 25, 2006, entitled Gear Assembly. Also enclosed with the letter were an inventor's Declaration form, an Assignment form, and a Power of Attorney form for his review and execution. A copy of the October 9, 2007 letter, patent application, and forms as sent to Mr. Davenne are attached. I sent the letter to Mr. Davenne's last known address at the time. Thereafter I learned that Mr. Davenne signed for the package and that the shipment was delivered as shown in the attached tracking history for DHL No. 7407809953, the entries entitled "Signed for by" and "10/11/2007 10:46 am."

On October 22, 2007, I sent Mr. Davenne the attached follow-up letter dated October 22, 2007 which was sent to him by courier (i.e. DHL No. 7407809032). The letter requested Mr.

Davenne to contact me as soon as possible. Thereafter I learned that Mr. Davenne signed for the package and that the shipment was delivered as shown in the attached tracking history for DHL No. 7407809032, the entries entitled "Signed for by" and "10/24/2007 11:12 am." Mr. Davenne has neither sent executed application papers nor contacted me.

In addition to my above-mentioned efforts to contact Mr. Davenne and obtain execution of the formal documents, and upon information and belief, my former colleagues in the United Kingdom previously attempted to contact Mr. Davenne and obtain execution of the documents. Attached are three letters dated November 8, 2006, November 22, 2006 and December 20, 2006 addressed to Mr. Davenne and from Ms. Cathy Kelly, Intellectual Property Formalities Administrator of BOC Edwards (now Edwards, Ltd. and formerly The BOC Group, plc and The Linde Group). Notably, Mr. Davenne left BOC Edwards in November 2006. Also attached is a May 11, 2007 email from Ms. Tribe to Ms. Lee explaining that inventor John Smith signed the documents and that the documents were given to Mr. Davenne for his execution, "but he refused to sign them and left them on his desk upon departure."

#### **Details of Refusal of Nonsigning Inventor to Sign Application Papers**

Despite the above-mentioned attempts by myself and my colleagues to contact Mr. Davenne, he has still not executed the application papers. Accordingly, in view of the above-mentioned facts, Mr. Davenne has refused to join in the application.

Mary K. Nicholes

Name of Person making Statement

Mary K. Nicholes

Signature of Person making Statement

10/26/07

Date



PTO/SB/81 (01-08)

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**POWER OF ATTORNEY  
and  
CORRESPONDENCE ADDRESS  
INDICATION FORM**

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

☒ Practitioners associated with the Customer Number:

020411

OR

☐ Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number:

OR

☐ The address associated with Customer Number:

020411

☐ Firm or Individual Name

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City

State

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Telephone

Email

I am the:

☒ Applicant/Inventor.☐ Assignee of record of the entire interest. See 37 CFR 3.71.  
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)**SIGNATURE of Applicant or Assignee of Record**

Signature		Date	11/12/2006
Name	JOHN CAMBRIDGE SMITH	Telephone	
Title and Company			

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below\*.

☐ \*Total of \_\_\_\_\_ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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55 Madison Avenue  
Morristown, NJ 07960  
USA

Tel: +1 973 285 3309  
In USA: +1 800 848 9800  
Fax: +1 973 285 3320

Mr. Tristan Richard Ghislain Davenne  
5 Adelaide Square  
Shoreham-by-Sea  
West Sussex  
BN43 6LN  
United Kingdom

August 28, 2007

**RE: U.S. Patent Application No. 10/594,260**  
**Filing Date: September 25, 2006**  
**Title: GEAR ASSEMBLY**  
**Docket No. M04B101**

Dear Mr. Davenne:

Enclosed please find a copy of the above-referenced patent application for the invention of which you are a co-inventor. Also enclosed for your execution is (a) an inventor's Declaration to be signed (and dated) by you in blue ink; (b) an Assignment which you should sign on the same date that you sign (and date) the Declaration; and (c) a Power of Attorney and Correspondence Address Indication Form which you should also please sign and date.

Please review the application carefully and make sure that you agree with its contents prior to executing the Declaration.

If there are no changes to be made, please read the Declaration carefully, paying particular attention to the fact that, by signing the Declaration, you acknowledge the following:

- a) To the best of your knowledge, you are the first and true inventor of the subject matter of the patent application.
- b) You owe the highest duty of candor and good faith in your dealings with the Patent and Trademark Office, and in discharge of this duty, you must disclose to the Patent and Trademark Office any information of which you are aware that is "material to examination of this application" as defined in the attached 37 CFR § 1.56. Such information is material when, at least in part, there is a substantial likelihood that a patent examiner would consider it important in deciding whether the subject matter of the present application is patentable.

After these steps have been taken, please sign (and date) the Declaration.

The Assignment should be signed by you and witnessed at the same time that you sign and date the Declaration.



The Power of Attorney and Correspondence Address Indication Form should be signed and dated by you.

Please return the application copy with the signed Declaration, signed Assignment and signed Power of Attorney. The extra copy of the application is for your records.

I look forward to receiving these papers as soon as possible, but by no later than **September 14, 2007**.

On behalf of BOC Edwards, Inc., thank you once for your submittal of the above-referenced invention record on which the patent application is based. If you have any concerns or questions, please do not hesitate to contact me.

Best Regards,



Kristi Nicholes | Patent Agent | Edwards

Tel: 1 973 285 3309 | Mobile: 1 862 812 4944 | [kristi.nicholes@edwardsvacuum.com](mailto:kristi.nicholes@edwardsvacuum.com)

55 Madison Avenue, Morristown, NJ 07960, USA | [www.edwardsvacuum.com](http://www.edwardsvacuum.com)  
BOC Edwards Inc.



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**802404455**  
Shipper's Reference (up to 35 characters)  
**M04B101**

Company Name  
**BOC EDWARDS, INC**  
Address  
**STE 400**  
**55 MADISON AVE**  
**MORRISTOWN NJ**  
Post/ZIP Code (required)  
**079607337**  
Phone, Fax, or E-mail (required)  
**973 285 3314**

**3 To (Receiver)**  
Company Name  
Contact Person  
**Tristan Richard Ghislain Davenne**  
Delivery Address DHL Cannot Deliver to a PO Box  
**5 Adelaide Square**  
**Shoreham-By-Sea**  
**West Sussex**

Country  
**UNITED KINGDOM**  
Post/ZIP Code (required)  
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**60240455**

Shipper's Reference (up to 35 characters)  
**M04B101**

Contact Name  
**Betty Lee**

**3 To (Receiver)**

Company Name  
**BOC EDWARDS, INC**

Address  
**STE 400  
55 MADISON AVE  
MORRISTOWN, NJ**

Post/ZIP Code (required)  
**07960**

Phone, Fax, or E-mail (required)  
**973 285 3314**

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Signature (required) *Betty Lee* Date *11/11/07*

7/11/07

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☐ Dom. Priority ☐ Dom. Standard

Other \_\_\_\_\_

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<b>DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION</b> <b>(37 CFR 1.63)</b>		Attorney Docket Number	M04B101
		First Named Inventor	DAVENNE et al.
		COMPLETE IF KNOWN	
		Application Number	10/594,260
		Filing Date	September 25, 2006
<input type="checkbox"/> Declaration Submitted With Initial Filing         OR <input checked="" type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)		Art Unit	
		Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

GEAR ASSEMBLY

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 03/22/2005 as United States Application Number or PCT International

Application Number PCT/GB2005/001087 and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
0406887.0	GB	03/26/2004	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**DECLARATION — Utility or Design Patent Application**

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NAME OF SOLE OR FIRST INVENTOR:		<input type="checkbox"/> A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))		Family Name or Surname		
TRISTAN RICHARD GHISLAIN		DAVENNE		
Inventor's Signature				Date
Residence: City	State	Country	Citizenship	
Shoreham-By-Sea, West Sussex		UNITED KINGDOM	UNITED KINGDOM	
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<input checked="" type="checkbox"/> Additional inventors or a legal representative are being named on the <u>one</u> supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.				

**DECLARATION****ADDITIONAL INVENTOR(S)**

Supplemental Sheet

Page 1 of 1

<b>Name of Additional Joint Inventor, if any:</b>		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
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<b>Name of Additional Joint Inventor, if any:</b>		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
Inventor's Signature		Date	
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<b>Name of Additional Joint Inventor, if any:</b>		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
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§ 1.56 DUTY TO DISCLOSE INFORMATION MATERIAL TO PATENTABILITY. (Added 3/16/92)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine: (Added 3/16/92)

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and (Added 3/16/92)
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office. (Added 3/16/92)

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and (Added 3/16/92)

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or (Added 3/16/92)
  - (2) It refutes, or is inconsistent with, a position the applicant takes in: (Added 3/16/92)
    - (i) Opposing an argument of unpatentability relied on by the Office, or (Added 3/16/92)
    - (ii) Asserting an argument of patentability. (Added 3/16/92)
- A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (Added 3/16/92)

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are: (Added 3/16/92)

- (1) Each inventor named in the application; (Added 3/16/92)
- (2) Each attorney or agent who prepares or prosecutes the application; and (Added 3/16/92)
- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. (Added 3/16/92)

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor. (Added 3/16/92)

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application. (Added 11/7/00)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al. Attorney Docket No.: M04B101  
International Application No.: PCT/GB2005/001087 Group Art Unit:  
International Application Filing Date: March 22, 2005  
National Application Filed: Concurrently Herewith  
Title: GEAR ASSEMBLY

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**PRELIMINARY AMENDMENT**

**37 C.F.R. § 1.115**

Dear Sir:

Prior to examining the above-identified application, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2.

Amendments to the Claims begin on page 6.

Amendments to the Drawings begin on page 9.

Remarks begin on page 10.



**IN THE SPECIFICATION**

Please amend page 1 by inserting the following heading between the title of the invention and the first paragraph:

**"FIELD OF THE INVENTION"**

Please amend page 1 by inserting the following heading between the first and second paragraphs:

**"BACKGROUND OF THE INVENTION"**

Please amend page 2 by inserting the following heading on line 8:

**"SUMMARY OF THE INVENTION"**

Please amend page 4 by inserting the following heading on line 14:

**"BRIEF DESCRIPTION OF THE DRAWINGS"**

Please amend page 4 by inserting the following heading on line 25:

**"DETAILED DESCRIPTION OF THE INVENTION"**

Please amend page 7 by inserting the following language between the "CLAIMS" heading and claim 1:

**"I/We claim:"**

Please amend pages 2-4 by deleting the following text beginning on page 2 line 20 and ending on page 4 line 2 as follows:

~~"In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.~~

~~The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the~~

~~members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.~~

~~The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.~~

~~Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.~~

~~In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.~~

~~This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem."~~

Please amend page 4 beginning on line 30 as follows:

"...teeth 16. There is a resilient coupling located between the hub member 12 and the annular member 14. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent. The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft."

Please amend page 5 beginning on line 14 by inserting the following text:

"The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially..."

Please amend page 6 beginning on line 9 as follows:

"In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1 :1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

While the foregoing description and drawings represent the preferred embodiments of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the true spirit and scope of the present invention."

## **IN THE CLAIMS**

This listing of claims will replace all prior versions and listings of claims in the application.

## **LISTING OF CLAIMS**

1. (currently amended) A gear assembly for transmitting torque from one shaft to another, ~~the gear assembly~~ comprising:  
two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, ~~;~~  
a toothed annular member mounted for rotation with the hub member, ~~;~~ and  
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.
2. (currently amended) A The gear assembly according to ~~C~~claim 1, wherein the means for reducing torsional vibrations and noise comprises means for increasing the critical eccentricity of the gear.
3. (currently amended) A The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise comprises a resilient coupling between the hub member and the annular member.
4. (currently amended) A The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise is located between a radial surface of the hub member and an opposing radial surface of the annular member.
5. (currently amended) A The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise is located

within a drive mechanism for transferring torque between the hub member and the annular member.

6. (currently amended) A-The gear assembly according to Gclaim 5; wherein one of the hub member and the annular member comprises a recess for receiving a detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.
7. (currently amended) A-The gear assembly according to Gclaim 6; wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
8. (currently amended) A-The gear assembly according to ~~any preceding claim 1~~; wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
9. (currently amended) A-The gear assembly according to Gclaim 8; wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
10. (currently amended) A-The gear assembly according to Gclaim 9; wherein each resilient member comprises a spring for providing torsional resistance.
11. (currently amended) A-The gear assembly according to Gclaim 9; wherein each resilient member comprises a plurality of springs for providing torsional resistance.

12. (currently amended) A The gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.
13. (currently amended) A The gear assembly according to ~~any of Claims 1 to 7~~, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
14. (currently amended) A The gear assembly according to ~~any preceding claim 1~~, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
15. (currently amended) A The gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
16. (currently amended) A vacuum pump comprising at least two shafts connected together by a gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts;  
a toothed annular member mounted for rotation with the hub member; and  
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears. ~~according to any preceding claim.~~
17. (currently amended) A gear for transmitting torque from one shaft to another;  
~~the gear comprising:~~  
a hub member for receiving one of the shafts;  
a toothed annular member mounted for rotation with the hub member; and

means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.

18. Cancelled



**IN THE DRAWINGS**

Fig. 1 has been amended to include a "Prior Art" legend.

Fig. 3 has been amended to included identifier "28".

**REMARKS**

This application is being filed concurrently with entry into the National Stage (Chapter 1) of International Application No. PCT/GB2005/001087 which claims the priority of Great Britain Patent Application No. 0406887.0.


This Preliminary Amendment was considered when calculating the filing fee. Accordingly, the total number of claims specified on the Transmittal Letter is 17 and the number of independent claims is 3.

The Specification has been amended to place the application in proper U.S. format. Headings have been added to each section. In addition, the text deleted from page 2 lines 20-30 has been inserted on page 4 line 30. The text deleted from page 3 lines 1-15 has been inserted on page 5 line 14. Finally, the text deleted from page 3 lines 17-32 and page 4 lines 1-2 has been inserted on page 6 line 10. No new matter has been introduced.

Claims 1-17 remain in the application and claim 18 has been cancelled. Claims 1-17 have been amended to eliminate multiple dependencies in these claims and to place the claims in proper U.S. format. Figures 1 and 3 have also been amended to place these drawings in proper U.S. format.

It is not believed at this time that any additional fee is due. As a precaution, the Commissioner is hereby authorized to charge to Deposit Account No. 02-2865 any additional fee required by this submission.

Respectfully submitted,

  
Ira Lee Zebrak  
Registration No. 31,147  
Attorney for Applicant(s)  
Date: *Sept 22, 2006*

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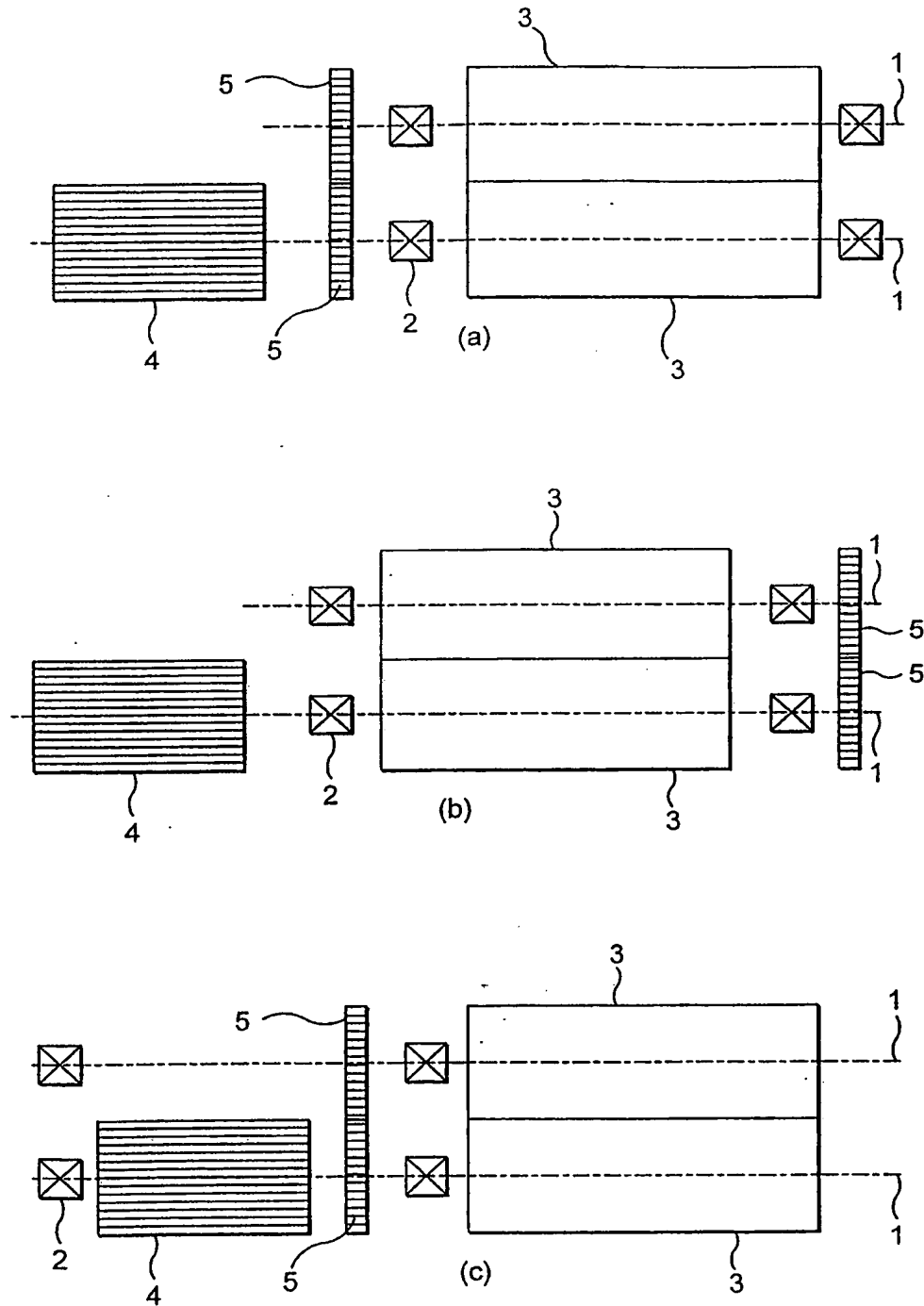


FIG. 1

(PRIOR ART)

2 / 2

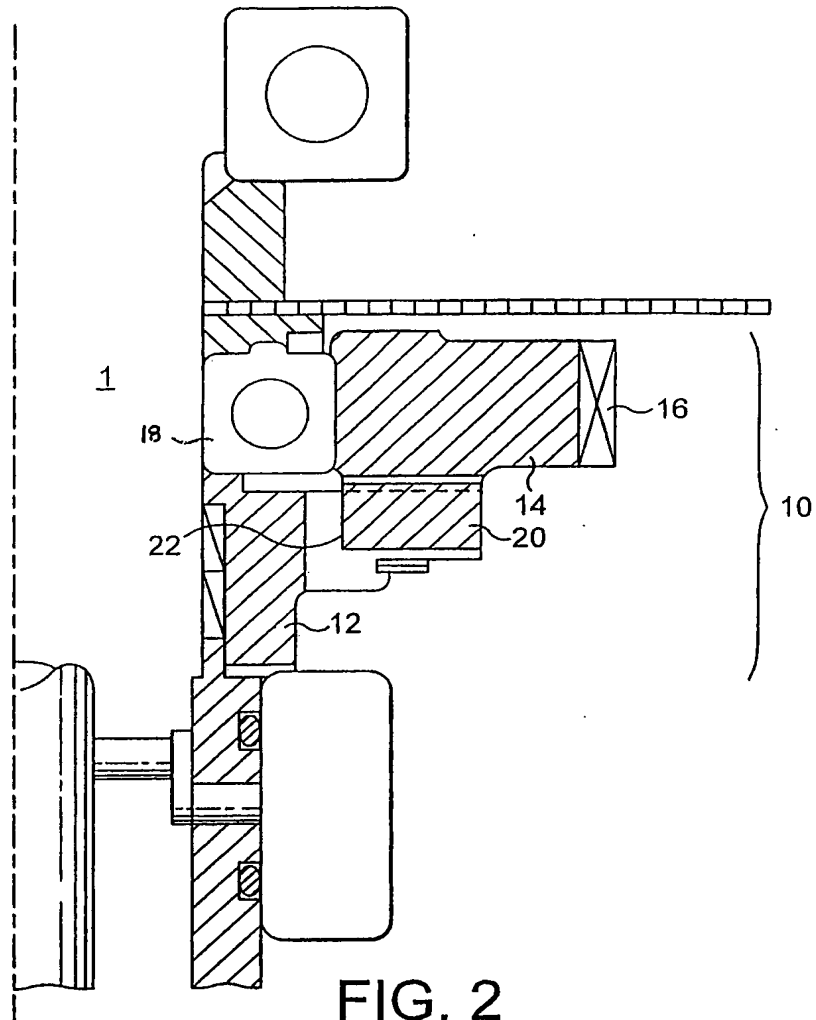


FIG. 2

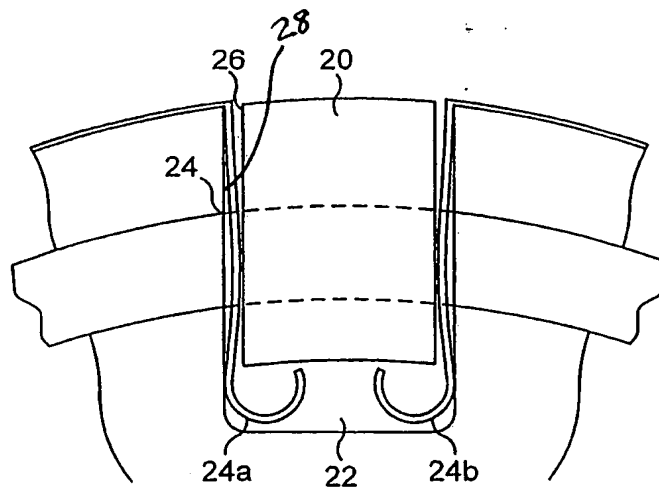


FIG. 3

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
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(21) International Application Number:  
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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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(72) Inventors; and

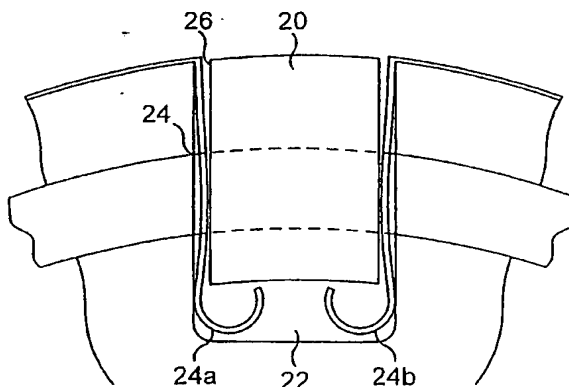
(75) Inventors/Applicants (*for US only*): **DAVENNE, Tristan, Richard, Ghislain** [GB/GB]; Boc Edwards, Unit 2, 23 Dolphin Road, Shoreham By Sea, West Sussex, BN43 6PB (GB). **SMITH, John, Cambridge** [GB/GB]; Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX (GB).

Published:

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: GEAR ASSEMBLY



(57) Abstract: A gear assembly for transmitting torque from one shaft to another comprises two intermeshing gears mounted on respective shafts. One of the gears comprises a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member. At least one spring provided between the hub member and the annular member has stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

WO 2005/093293 A1

- 1 -

### GEAR ASSEMBLY

The present invention relates to a gear assembly for transmitting torque from one shaft to another, and to a gear suitable for use in such an assembly. The gear  
5 assembly is particularly useful for transmitting torque between shafts of a vacuum pump.

With reference to Figure 1, a known vacuum pump includes a pumping chamber through which pass a pair of parallel shafts 1 supported by bearings 2. A rotor 3  
10 is mounted on each shaft 1 for rotation within the pumping chamber. The rotors 3 have complementary pumping profiles, which may be Roots, Northey (or "claw") or screw. In use, when a motor 4 is driving one of the shafts 1, the other shaft is rotated synchronously with that shaft by means of the meshed timing gears 5. The rotors 3 are so profiled that fluid to be pumped is drawn into an inlet of the  
15 pumping chamber and exits from the pumping chamber via an outlet.

Figure 1 illustrates three different pumping configurations. In Figure 1(a), the rotors 3 are mounted between the bearings 2 and the timing gears 5 are provided at the motor-driven end of the pump. In Figure 1(b), the timing gears 5 are  
20 provided at the other end of the pump, and Figure 1(c) illustrates a configuration using cantilevered rotors.

Transmission of torque through the meshed gears 5 is affected by gear eccentricity. Gear eccentricity results in an oscillating drive torque, which would  
25 normally be constant with concentric gears. In the case of high inertia, lightly loaded, rotating machinery driven by gears with typical manufacturing eccentricity tolerances, the magnitude of the oscillating drive torque can exceed the steady state drive torque. As a result, the gears leave mesh, which can provoke high frequency tooth-to-tooth slapping, a characteristic noise frequently encountered in  
30 lightly loaded rotating machinery.

- 2 -

Pump design has been improved to reduce friction and power consumption. Consequently the required steady state drive torque has reduced and thus rotating machinery has become increasingly prone to eccentricity induced torsional vibrations and related noise problems.

5

It is an aim of at least the preferred embodiment of the present invention to reduce such torsional vibrations and noise by accommodating typical gear eccentricities.

10

In one aspect, the present invention provides a gear assembly for transmitting torque from one shaft to another, the gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

20

The means for inhibiting torsional vibrations and noise preferably comprises a resilient coupling between the hub member and the annular member. This coupling is preferably located between opposing surfaces of the members. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.

30

The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

- 3 -

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member.

Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled.

By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention



- 4 -

fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

In another aspect the present invention provides a gear for transmitting torque  
5 from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by the eccentricity of the annular member.

10 A further aspect of the invention provides use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

15 Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates schematically three known pump configurations;

20 Figure 2 is a cross-section of a gear suitable for use in any of the pumps of Figure 1; and

Figure 3 is a cross-section illustrating the mechanism for transmitting torque between the hub member and annular member of the gear of Figure 2.

25 With reference to Figure 2, a gear 10 suitable for use in any of the vacuum pumps shown in Figure 1 or in any other lightly loaded, high inertia rotating machine comprises a hub member 12 for receiving a shaft of the pump and an annular member 14 mounted for rotation with the hub member 12 and having peripheral  
30 teeth 16. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft.

In use, the peripheral teeth 16 of the annular member 14 are in meshing engagement with the corresponding teeth of another gear having a 1:1 gear ratio with the gear 10, similar to the timing gears 5 shown in Figure 1.

5

A drive mechanism for transmitting torque between the members 12, 14 is provided by a plurality of detents provided around a surface perpendicular to the rotational axis of one of the members which enter respective recesses provided around the facing axial surface of the other member. In the embodiment shown in Figure 2, detents 20 are provided on the annular member 14 and recesses 22 are provided on the hub member 12, although this could be the other way around, with the detents being provided on the hub member and the recesses provided on the annular member.

15 As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially inhibit torsional vibrations and noise induced under lightly loaded conditions by eccentricity of either the annular member 14 or of the gear meshing with the teeth 16 of the annular member 14. The springs 24a, 24b also provide absorption of any tooth-to-tooth impact resulting from external disturbances.

Under lightly loaded conditions, as experienced by a pump operating at ultimate pressure, the transmission of torque between the members 12, 14 is through one of the springs 24a, 24b provided within each recess 22. This provides a degree of resilience necessary to accommodate any gear eccentricity.

In the event of the pump being subject to higher loads where a solid drive is needed to avoid compromising the phase relationship between the driving and driven shafts, the spring flattens between the facing radial surfaces 26, 28 once the angular deflection of the spring has reached a specified value above a

30

- 6 -

predetermined drive torque. This provides the necessary solid drive between the radial faces 26, 28.

Whilst in this embodiment flat springs have been used to control torsional stiffness,  
5 tangentially mounted disc springs or coil springs could be used instead.  
Alternatively, repelling magnets could be used, with the resulting torsional stiffness being proportional to the magnetic flux. In some applications, use of viscoelastic materials may be appropriate.

CLAIMS

1. A gear assembly for transmitting torque from one shaft to another,  
5 the gear assembly comprising two intermeshing gears mounted on  
respective shafts, one of the gears comprising a hub member for  
receiving one of the shafts, a toothed annular member mounted for  
rotation with the hub member, and means provided between the hub  
member and the annular member having a stiffness capable of  
10 reducing torsional vibrations and noise induced during rotation of the  
gears by the eccentricity of at least one of the gears.
2. A gear assembly according to Claim 1, wherein the means for  
reducing torsional vibrations and noise comprises means for  
15 increasing the critical eccentricity of the gear.
3. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise comprises a  
resilient coupling between the hub member and the annular member.  
20
4. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise is located between  
a radial surface of the hub member and an opposing radial surface of  
the annular member.  
25
5. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise is located within a  
drive mechanism for transferring torque between the hub member  
and the annular member.  
30
6. A gear assembly according to Claim 5, wherein one of the hub  
member and the annular member comprises a recess for receiving a

- 8 -

detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.

5

7. A gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.

10

8. A gear assembly according to any preceding claim, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.

15

9. A gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.

20

10. A gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.

25

11. A gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.

30

12. A gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.

- 9 -

13. A gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
- 5 14. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
- 10 15. A gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
- 15 16. A vacuum pump comprising at least two shafts connected together by a gear assembly according to any preceding claim.
17. A gear for transmitting torque from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed  
20 annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.
- 25 18. Use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

1 / 2

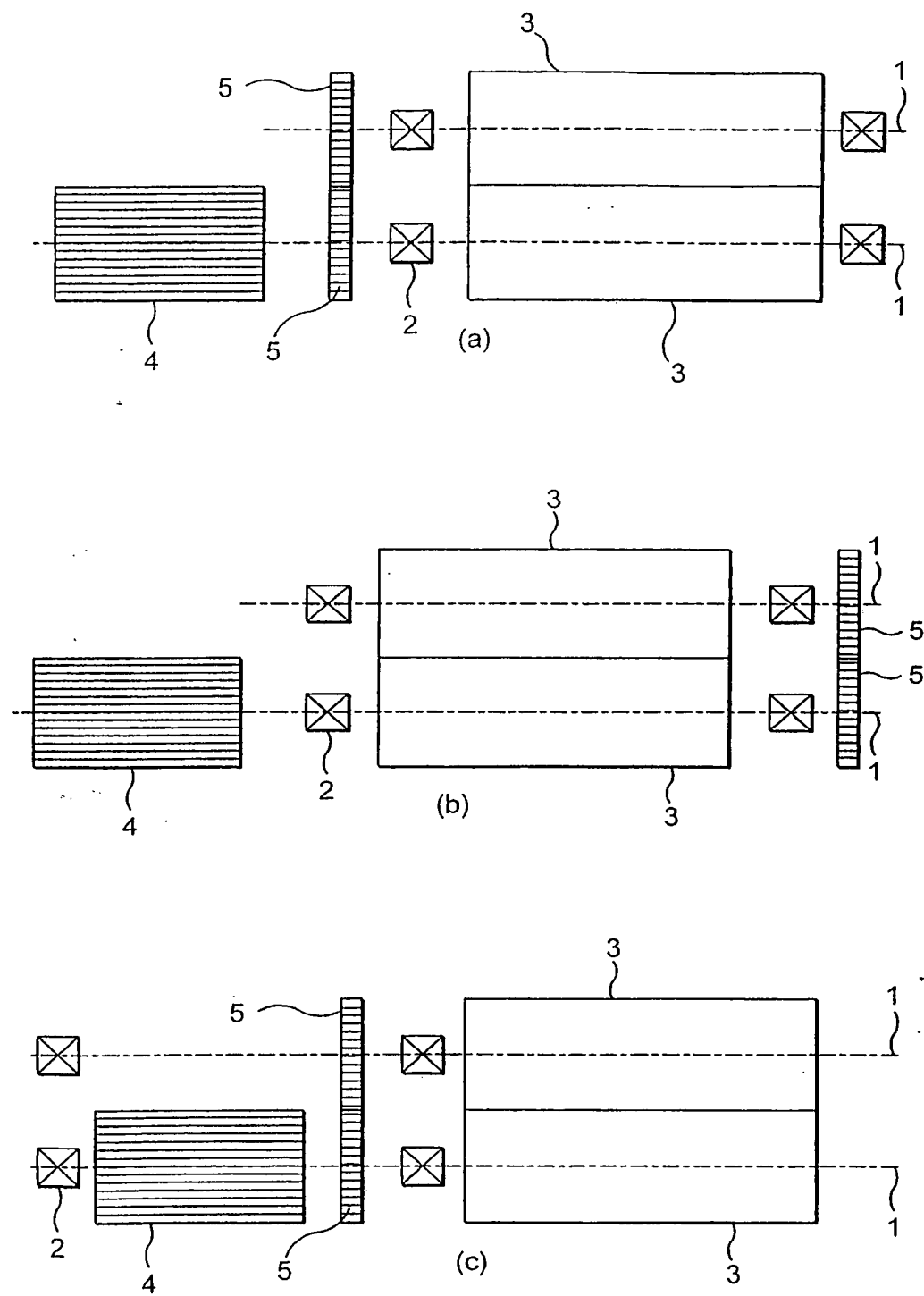


FIG. 1

2 / 2

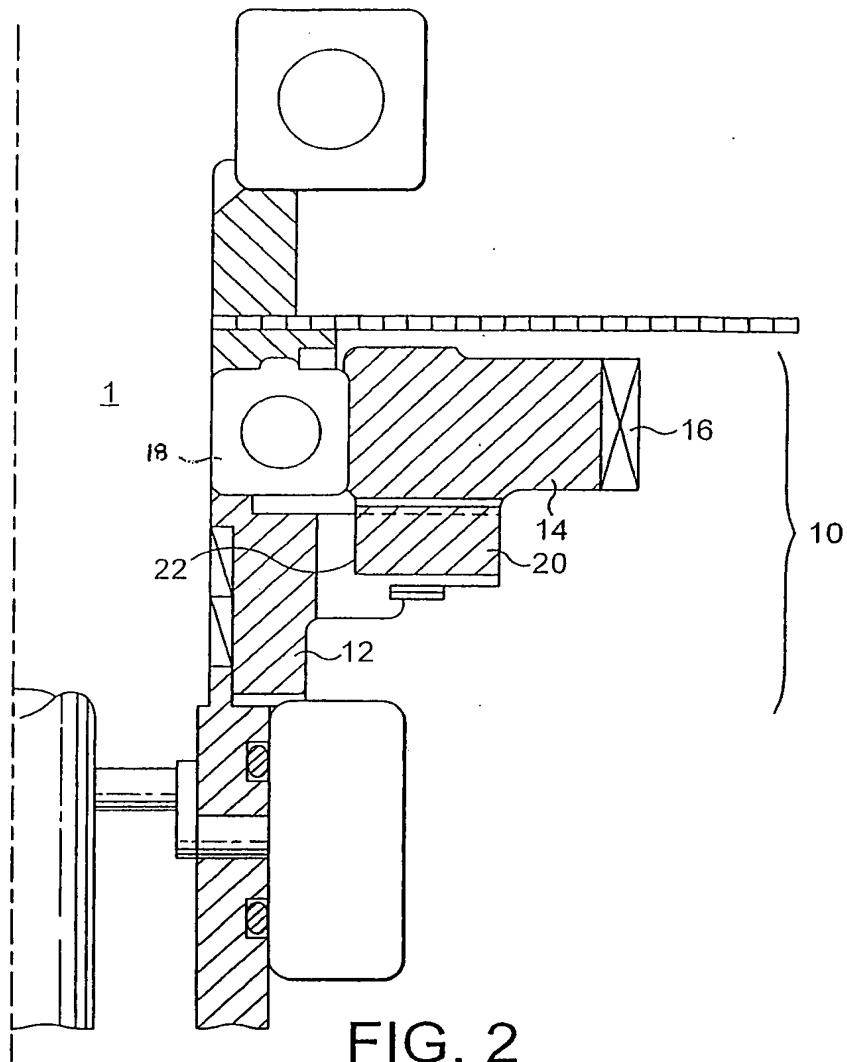


FIG. 2

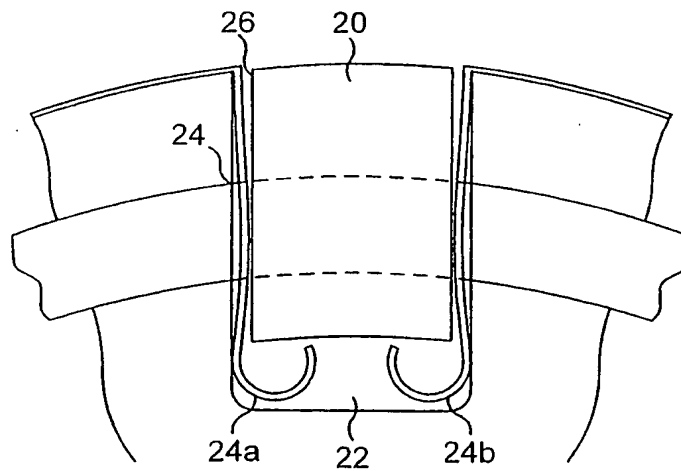


FIG. 3



# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB2005/001087

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 F16H55/14 F16H57/00 F16D3/52 F04C29/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 F16D F16H F04C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, PAJ		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 344 945 A (EATON CORPORATION) 6 December 1989 (1989-12-06) claim 1; figures 2-6	1-3, 5, 8, 14, 16-18
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 04, 2 April 2003 (2003-04-02) & JP 2002 349672 A (MITSUBISHI MOTORS CORP), 4 December 2002 (2002-12-04) abstract; figures 1, 3	1-9, 12, 14-17
X	US 86 533 A (JOHN HAFFNER) 2 February 1869 (1869-02-02) figure 5	1-5, 8, 14, 17, 18
X	US 5 692 410 A (FENELON ET AL) 2 December 1997 (1997-12-02) the whole document	1-11, 14, 17, 18
-/--		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search  10 June 2005		Date of mailing of the international search report  22/06/2005
Name and mailing address of the ISA European Patent Office, P.B. 6818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer  Meyer, T

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB2005/001087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 3 991 818 A (WAGNER ET AL) 16 November 1976 (1976-11-16)  the whole document -----	1-5, 8-12,14, 17,18
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB2005/001087

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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US 5893355	A	13-04-1999	NONE	

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INDICATION FORM**

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

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020411

OR

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as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

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I am the:

☒ Applicant/Inventor.☐ Assignee of record of the entire interest. See 37 CFR 3.71.  
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)**SIGNATURE of Applicant or Assignee of Record**

Signature

Date

Name

TRISTAN RICHARD GHISLAIN DAVENNE

Telephone

Title and Company

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below\*.

☐ \*Total of \_\_\_\_\_ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

**ASSIGNMENT**

**WHEREAS, I/We**, Tristan Richard Ghislain Davenne and John Cambridge Smith, a citizen of/ citizens of the United Kingdom, residing at 5 Adelaide Square, Shoreham-by-Sea, West Sussex, BN43 6LN, United Kingdom; and Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX, United Kingdom, have invented certain new and useful improvements in GEAR ASSEMBLY for which I/We have made application for Letters Patent of the United States, which application may be identified in the United States Patent and Trademark Office as Serial No. 10/594,260, filed September 25, 2006; which application claims priority from International Application No. PCT/GB2005/001087, filed March 22, 2005; and,

**WHEREAS, The BOC Group plc**, an English Company of Chertsey Road, Windlesham, Surrey GU20 6HJ, England, is desirous of obtaining the entire right, title and interest in, to and under the said improvements and the said application:

**NOW, THEREFORE**, in consideration of the sum of One Dollar (\$1.00) to me/us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, I/WE, the said Tristan Richard Ghislain Davenne and John Cambridge Smith have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said **The BOC Group plc**, its successors, legal representatives and assigns, the entire right, title and interest in, to and under the invention, the said improvements, and the said application, all applications derived therefrom and all continuing prosecution applications, conversions, divisions, renewals and continuations thereof, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof, and all applications for Letters Patent or Inventor's Certificates which may hereafter be filed for said improvements in any country or countries foreign to the United States, and all Letters Patent or Inventor's Certificates which may be granted for said improvements in any country or countries foreign to the United States and all extensions, renewals and reissues thereof; and I/We hereby authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all Letters Patent for said improvements to the said **The BOC Group plc**, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

**I/WE HEREBY** covenant that I/We have full right to convey the entire interest herein assigned, and that I/WE have not executed, and will not execute, any agreement in conflict herewith.

**AND I/WE HEREBY** further covenant and agree that I/We will communicate to the said **The BOC Group plc**, its successors, legal representatives and assigns, any facts known to me/us respecting said invention and said improvements, and testify in any legal proceeding, sign all lawful papers, execute all continuing prosecution, divisional, continuing, reexamination and reissue applications, make all rightful oaths, and generally do everything possible to aid the said **The BOC Group plc**, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said inventions and improvements in all countries.

Date

Assignor

Witnessed By:

\_\_\_\_\_  
Tristan Richard Ghislain Davenne

\_\_\_\_\_  
At: \_\_\_\_\_

\_\_\_\_\_  
John Cambridge Smith

\_\_\_\_\_  
At: \_\_\_\_\_




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8:01 am	With delivery courier.	Gatwick, United Kingdom
9/1/2007 7:00 am	Arrived at DHL facility.	Gatwick, United Kingdom
3:55 am	Depart Facility	East Midlands, United Kingdom
8/31/2007 2:06 am	In transit.	Wilmington - Clinton Field, OH
2:00 am	In transit.	Wilmington - Clinton Field, OH
8/30/2007 10:17 pm	Shipment picked up	Parsippany, NJ
9:00 pm	Departing origin.	Parsippany, NJ
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**Lee, Betty**

---

**From:** Tribe, Julia  
**Sent:** Tuesday, September 25, 2007 4:05 AM  
**To:** Lee, Betty  
**Subject:** RE: Tristan Davenne

Betty

In answer to your query, the address that HR have for him is:

15 Chapel Road  
Epping  
Essex  
CM16 5DS

However, searches on the internet indicate that he lives in Sussex, which indicates that the HR address may be more out of date than the address we have.

I suggest you try both addresses, but he flatly refused to sign anything before he left BOC.

Good luck!

*Julia*

**Julia Tribe** | Intellectual Property Formalities Administrator | Edwards  
Tel: +44 (0)1293 603341 | Fax: +44 (0)1293 407451 | [julia.tribe@edwardsvacuum.com](mailto:julia.tribe@edwardsvacuum.com)  
Manor Royal, Crawley, West Sussex, RH10 9LW, UK | [www.edwardsvacuum.com](http://www.edwardsvacuum.com)

Edwards Ltd | Registered in England and Wales No. 6124750  
Registered office: Manor Royal, Crawley, West Sussex RH10 9LW

---

**From:** Tribe, Julia  
**Sent:** 14 September 2007 12:03  
**To:** Lee, Betty  
**Cc:** Nicholes, Kristi  
**Subject:** Tristan Davenne

Hi Betty

I hope you had a good holiday.

The last known address for Tristan Davenne is as on CPi:

5 Adelaide Square  
Shoreham-by-Sea  
West Sussex BN43 6LN

Good luck!

10/25/2007





LEGAL SERVICES - INTELLECTUAL PROPERTY

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Morristown, NJ 07960  
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In USA: +1 800 848 9800  
Fax: +1 973 285 3320

VIA DHL

October 9, 2007

Mr. Tristan Richard Ghislain Davenne  
15 Chapel Road  
Epping  
Essex CM16 5DS  
United Kingdom

RE: U.S. Patent Application No. 10/594,260  
Filing Date: September 25, 2006  
Title: GEAR ASSEMBLY  
Dkt. No. M04B101

Dear Mr. Davenne:

Enclosed please find a copy of the above-referenced patent application for the invention of which you are a co-inventor. Also enclosed for your execution is (a) an inventor's Declaration to be signed (and dated) by you in blue ink; (b) an Assignment which you should sign on the same date that you sign (and date) the Declaration; and (c) a Power of Attorney and Correspondence Address Indication Form which you should also please sign and date.

Please review the application carefully and make sure that you agree with its contents prior to executing the Declaration.

If there are no changes to be made, please read the Declaration carefully, paying particular attention to the fact that, by signing the Declaration, you acknowledge the following:

- a) To the best of your knowledge, you are the first and true inventor of the subject matter of the patent application.
- b) You owe the highest duty of candor and good faith in your dealings with the Patent and Trademark Office, and in discharge of this duty, you must disclose to the Patent and Trademark Office any information of which you are aware that is "material to examination of this application" as defined in the attached 37 CFR § 1.56. Such information is material when, at least in part, there is a substantial likelihood that a patent examiner would consider it important in deciding whether the subject matter of the present application is patentable.

After these steps have been taken, please sign (and date) the Declaration.

The Assignment should be signed by you and witnessed at the same time that you sign and date the Declaration.

The Power of Attorney and Correspondence Address Indication Form should be signed and dated by you.

Please return the application copy with the signed Declaration, signed Assignment and signed Power of Attorney. The extra copy of the application is for your records.

I look forward to receiving these papers as soon as possible.

On behalf of Edwards Vacuum, Inc., thank you once for your submittal of the above-referenced invention record on which the patent application is based. If you have any concerns or questions, please do not hesitate to contact me.

Best Regards,

A handwritten signature in black ink, appearing to read "Kristi Nicholes", with a stylized flourish at the end.

Kristi Nicholes | Patent Agent | Edwards

Tel: 1 973 285 3309 | Mobile: 1 862 812 4944 | [kristi.nicholes@edwardsvacuum.com](mailto:kristi.nicholes@edwardsvacuum.com)

Enclosures

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Charge to ☒ Shipper ☐ Receiver ☐ 3rd PartyPayer Account No. ☐ Cash ☐ Check ☐ Credit CardShipment Value Protection (see reverse) ☐ Yes Declared Value for Carriage (in US \$) ☐ Not all payment options are available in all countries.

## 2 From (Shipper)

Shipper's Account Number

Contact Name

Betty Lee

Shipper's Reference (up to 35 characters)

M04B101

CC17007518

Company Name

BOC EDWARDS, INC

Address

ST 400

55 MADISON AVE  
MORRISTOWN NJ

Post/ZIP Code (required)

071607337

Phone, Fax, or E-mail (required)

973 285 3314

## 3 To (Receiver)

Company Name

Contact Person

Mr. Tristan Richard Chislain Davenne

Delivery Address DHL Cannot Deliver to a PO Box

15 Chapel Road

Epping

Essex

Country

United Kingdom

Post/ZIP Code (required)

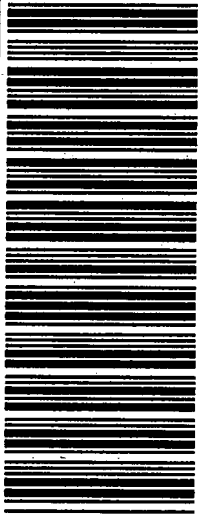
CM16 5DS

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2002

7/16/07



740780953

## 4 Shipment Details

Total number of packages

1

Total Weight If DHL Express Document packaging used, enter XD

3

Dimensions (in inches)

Pieces Length Width Height

X X X

X X X

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## 5 Full Description of Contents

Give Content and Quantity

DHL return envelope

business correspondence - 64 pages

no commercial value

## 6 Dutiable Shipments Only (Customs requirement)

Attach the original and four copies of a Proforma or Commercial Invoice.

Export License No./Symbol (if applicable) Receiver's VAT/GST or Shipper's EIN/SSN

Declared Value for Customs (in US \$)

Schedule B Number / Harmonized Code (if applicable)

AES TRANSACTION NUMBER

TYPE OF EXPORT ☐ Permanent ☐ Repair/Return ☐ Temporary

Destination Duties/Taxes If left blank, Receiver pays duties/taxes.

☐ Receiver ☐ Shipper ☐ Other

Specify approved account number

The commodities, technology or software to be exported from the U.S. are in compliance with the U.S. Bureau of Export Administration. Diversion to countries contrary to U.S. law prohibited.

7 Shipper's Authorization (signature required)

We agree that DHL's standard terms apply to this shipment and limit DHL's liability for loss or damage to the value of the shipment. We authorize DHL to complete other documents as required for shipment.

Value Protection is available on request, for an extra charge. We agree to pay all charges if the recipient or 3rd party refuses to pay. We understand that DHL DOES NOT TRANSPORT CASH.

Signature (required) *Betty Lee* Date 10 / 9 / 07

DHL EXPRESS (USA), INC.

DHL Express (USA), Inc., 1200 South Pine Island Road, Plantation, Florida 33324

Original (DHL Billing) Copy

<b>1 Payer account number and shipment value protection details</b> Charge to <input type="checkbox"/> Shipper <input checked="" type="checkbox"/> Receiver <input type="checkbox"/> 3rd Party Payer Account No. <b>968478330</b> Shipment Value Protection (see reverse) <input type="checkbox"/> Yes Declared Value for Carriage (in US \$) _____ <input type="checkbox"/> No		<b>2 From (Shipper)</b> Shipper's Account Number _____ Contact Name _____ Shipper's Reference (up to 35 characters) _____ Company Name <b>Mr. Tristan Richard Ghislain Davenne</b> Address <b>15 Chapel Road          Epping          Essex CM16 5DS          United Kingdom</b> Post/ZIP Code (required) <b>CM16 5DS</b> Phone, Fax, or E-mail (required) _____		<b>3 To (Receiver)</b> Company Name <b>Edwards Vacuum, Inc.</b> Contact Person <b>Betty Lee</b> Delivery Address DHL Cannot Deliver to a PO Box <b>Edwards Vacuum, Inc.          55 Madison Avenue, Suite 400          Morristown, New Jersey</b> Country <b>USA</b> Post/ZIP Code (required) <b>07960</b> Phone, Fax, or E-mail (required) <b>973 285 3314</b>		<b>4 Shipment Details</b> Total number of packages <b>one</b> If DHL Express Document packaging used, enter XD _____ Dimensions (in inches) Length _____ Width _____ Height _____ Pieces _____ Total Weight _____ lbs Dimensions (in inches) Length _____ Width _____ Height _____ Pieces _____		<b>5 Full Content and Quantity</b> Give Content and Quantity <b>business correspondence 34 pages</b>		<b>6 Dutiable Shipments Only (Customs requirement)</b> Attach the original and four copies of a Proforma or Commercial Invoice Export License No./Symbol (if applicable) Receiver's VAT/GST or Shipper's EIN/SSN _____ Declared Value for Customs (in US \$) _____ Schedule B Number / Harmonized Code (if applicable) _____ AES TRANSACTION NUMBER _____ TYPE OF EXPORT <input type="checkbox"/> Permanent <input type="checkbox"/> Repair/Return <input type="checkbox"/> Temporary Destination Duties/Taxes If left blank, Receiver pays duties/taxes. <input type="checkbox"/> Receiver <input type="checkbox"/> Shipper <input type="checkbox"/> Other _____ The commodities, technology or software to be exported from the U.S. are in compliance with the U.S. Bureau of Export Administration. Diversion to countries contrary to U.S. law prohibited.		<b>7 Shipper's Authorization (signature required)</b> I/we agree that DHL's standard terms apply to this shipment and limit DHL's liability for loss or damage to U.S. \$100. The Warsaw Convention may also apply (see reverse). I/we authorize DHL to complete other documents necessary to export this shipment. I/we understand that Shipment Value Protection is available on request, for an extra charge, I/we agree to pay all charges if the recipient or 3rd party refuses to pay. I/we understand that DHL DOES NOT TRANSPORT CASH. Signature (required) _____ Date _____ / _____ / _____	
<b>8 Products &amp; Services</b> Not all products or services are available at all locations. <input type="checkbox"/> International Express <input checked="" type="checkbox"/> Non-Dutiable International Document Service <input type="checkbox"/> Dutiable (Worldwide Priority Express) <input type="checkbox"/> Other _____ Service Options (extra charges may apply) <input type="checkbox"/> Saturday Delivery <input type="checkbox"/> Special Pickup <input type="checkbox"/> Delivery Notification <input type="checkbox"/> Signature Required Other _____ Global Mail <input type="checkbox"/> Int. Priority <input type="checkbox"/> Int. Standard <input type="checkbox"/> IPA <input type="checkbox"/> ISAL <input type="checkbox"/> Dom. Priority <input type="checkbox"/> Dom. Standard Other _____		DESTINATION CODE _____ ORIGIN _____		DIMENSIONAL/CHARGEABLE WEIGHT (lbs) _____ DIMENSIONAL/CHARGEABLE WEIGHT (kg) _____ SERVICES _____ CHARGES _____ Drop Box # _____ TOTAL _____ TRANSPORT COLLECT STICKER NO. _____ PAYMENT DETAILS (Check, Card No.) No. _____ Type _____ Expires _____ AUTH _____ PICKED UP BY _____ Route No. _____ Time _____ Date _____									

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**DECLARATION FOR UTILITY OR  
DESIGN  
PATENT APPLICATION  
(37 CFR 1.63)**Declaration  
Submitted  
With Initial  
Filing

OR

Declaration  
Submitted after Initial  
Filing (surcharge  
(37 CFR 1.16 (e))  
required)Attorney Docket  
Number

M04B101

First Named Inventor

DAVENNE et al.

**COMPLETE IF KNOWN**

Application Number

10/594,260

Filing Date

September 25, 2006

Art Unit

Examiner Name

**I hereby declare that:**

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**GEAR ASSEMBLY***(Title of the Invention)*

the specification of which



is attached hereto

OR



was filed on (MM/DD/YYYY)

03/22/2005

as United States Application Number or PCT International

Application Number

PCT/GB2005/001087

and was amended on (MM/DD/YYYY)

(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
0406887.0	GB	03/26/2004	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance completing the form, call 1-800-PTO-9199 and select option 2.

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**DECLARATION — Utility or Design Patent Application**

Direct all correspondence to:		<input checked="" type="checkbox"/> The address associated with Customer Number:	71134	OR	<input type="checkbox"/> Correspondence address below
Name					
Address					
City		State		ZIP	
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<b>WARNING:</b>					
<p>Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.</p>					
<p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.</p>					
<b>NAME OF SOLE OR FIRST INVENTOR:</b>			<input type="checkbox"/> A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])			Family Name or Surname		
TRISTAN RICHARD GHISLAIN			DAVENNE		
Inventor's Signature				Date	
Residence: City	State	Country	Citizenship		
EPPING, ESSEX		UNITED KINGDOM	UNITED KINGDOM		
Mailing Address 15 CHAPEL ROAD					
City	State	Zip	Country		
EPPING, ESSEX		CM16 5DS	UNITED KINGDOM		
<input checked="" type="checkbox"/> Additional inventors or a legal representative are being named on the one supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.					

§ 1.56 DUTY TO DISCLOSE INFORMATION MATERIAL TO PATENTABILITY. (Added 3/1/6/92)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine: (Added 3/1/6/92)

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and (Added 3/1/6/92)
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office. (Added 3/1/6/92)

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and (Added 3/1/6/92)

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or (Added 3/1/6/92)

(2) It refutes, or is inconsistent with, a position the applicant takes in: (Added 3/1/6/92)

- (i) Opposing an argument of unpatentability relied on by the Office, or (Added 3/1/6/92)
- (ii) Asserting an argument of patentability. (Added 3/1/6/92)

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (Added 3/1/6/92)

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are: (Added 3/1/6/92)

- (1) Each inventor named in the application: (Added 3/1/6/92)
- (2) Each attorney or agent who prepares or prosecutes the application; and (Added 3/1/6/92)
- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. (Added 3/1/6/92)

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor. (Added 3/1/6/92)

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application. (Added 11/7/00)

EXPRESS MAIL MAILING LABEL: EQ 467245893 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al.

Attorney Docket No.: M04B101

International Application No.: PCT/GB2005/001087 Group Art Unit:

International Application Filing Date: March 22, 2005

National Application Filed: Concurrently Herewith

Title: GEAR ASSEMBLY

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**PRELIMINARY AMENDMENT**

**37 C.F.R. § 1.115**

Dear Sir:

Prior to examining the above-identified application, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2.

Amendments to the Claims begin on page 6.

Amendments to the Drawings begin on page 9.

Remarks begin on page 10.



**IN THE SPECIFICATION**

Please amend page 1 by inserting the following heading between the title of the invention and the first paragraph:

**"FIELD OF THE INVENTION"**

Please amend page 1 by inserting the following heading between the first and second paragraphs:

**"BACKGROUND OF THE INVENTION"**

Please amend page 2 by inserting the following heading on line 8:

**"SUMMARY OF THE INVENTION"**

Please amend page 4 by inserting the following heading on line 14:

**"BRIEF DESCRIPTION OF THE DRAWINGS"**

Please amend page 4 by inserting the following heading on line 25:

**"DETAILED DESCRIPTION OF THE INVENTION"**

Please amend page 7 by inserting the following language between the "CLAIMS" heading and claim 1:

**"I/We claim:"**

Please amend pages 2-4 by deleting the following text beginning on page 2 line 20 and ending on page 4 line 2 as follows:

~~"In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.~~

~~The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the~~

members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem."

Please amend page 4 beginning on line 30 as follows:

"...teeth 16. There is a resilient coupling located between the hub member 12 and the annular member 14. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent. The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft."

Please amend page 5 beginning on line 14 by inserting the following text:

"The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially..."

Please amend page 6 beginning on line 9 as follows:

"In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1 :1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

While the foregoing description and drawings represent the preferred embodiments of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the true spirit and scope of the present invention."

## IN THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

## LISTING OF CLAIMS

1. (currently amended) A gear assembly for transmitting torque from one shaft to another, ~~the gear assembly comprising:~~  
two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, ~~and~~  
a toothed annular member mounted for rotation with the hub member, ~~and~~  
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.
2. (currently amended) ~~A~~The gear assembly according to ~~C~~claim 1, wherein the means for reducing torsional vibrations and noise comprises means for increasing the critical eccentricity of the gear.
3. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise comprises a resilient coupling between the hub member and the annular member.
4. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise is located between a radial surface of the hub member and an opposing radial surface of the annular member.
5. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim~~ 1, wherein the means for reducing torsional vibrations and noise is located

within a drive mechanism for transferring torque between the hub member and the annular member.

6. (currently amended) A-The gear assembly according to Claim 5, wherein one of the hub member and the annular member comprises a recess for receiving a detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.
7. (currently amended) A-The gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
8. (currently amended) A-The gear assembly according to ~~any preceding claim 1~~, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
9. (currently amended) A-The gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
10. (currently amended) A-The gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.
11. (currently amended) A-The gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.

12. (currently amended) A The gear assembly according to Gclaim 9, wherein each resilient member comprises a viscoelastic member.
13. (currently amended) A The gear assembly according to ~~any of G~~claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
14. (currently amended) A The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
15. (currently amended) A The gear assembly according to Gclaim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
16. (currently amended) A vacuum pump comprising at least two shafts connected together by a gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts;  
a toothed annular member mounted for rotation with the hub member; and  
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears. ~~according to any preceding claim.~~
17. (currently amended) A gear for transmitting torque from one shaft to another,  
~~the gear comprising;~~  
a hub member for receiving one of the shafts,  
a toothed annular member mounted for rotation with the hub member, and

means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.

18. Cancelled



**IN THE DRAWINGS**

Fig. 1 has been amended to include a "Prior Art" legend.

Fig. 3 has been amended to included identifier "28".

**REMARKS**

This application is being filed concurrently with entry into the National Stage (Chapter 1) of International Application No. PCT/GB2005/001087 which claims the priority of Great Britain Patent Application No. 0406887.0.


This Preliminary Amendment was considered when calculating the filing fee. Accordingly, the total number of claims specified on the Transmittal Letter is 17 and the number of independent claims is 3.

The Specification has been amended to place the application in proper U.S. format. Headings have been added to each section. In addition, the text deleted from page 2 lines 20-30 has been inserted on page 4 line 30. The text deleted from page 3 lines 1-15 has been inserted on page 5 line 14. Finally, the text deleted from page 3 lines 17-32 and page 4 lines 1-2 has been inserted on page 6 line 10. No new matter has been introduced.

Claims 1-17 remain in the application and claim 18 has been cancelled. Claims 1-17 have been amended to eliminate multiple dependencies in these claims and to place the claims in proper U.S. format. Figures 1 and 3 have also been amended to place these drawings in proper U.S. format.

It is not believed at this time that any additional fee is due. As a precaution, the Commissioner is hereby authorized to charge to Deposit Account No. 02-2865 any additional fee required by this submission.

Respectfully submitted,

  
Ira Lee Zebrak  
Registration No. 31,147  
Attorney for Applicant(s)  
Date: *Sept 22, 2006*

The BOC Group, Inc.  
Legal Services-Intellectual Property  
575 Mountain Avenue  
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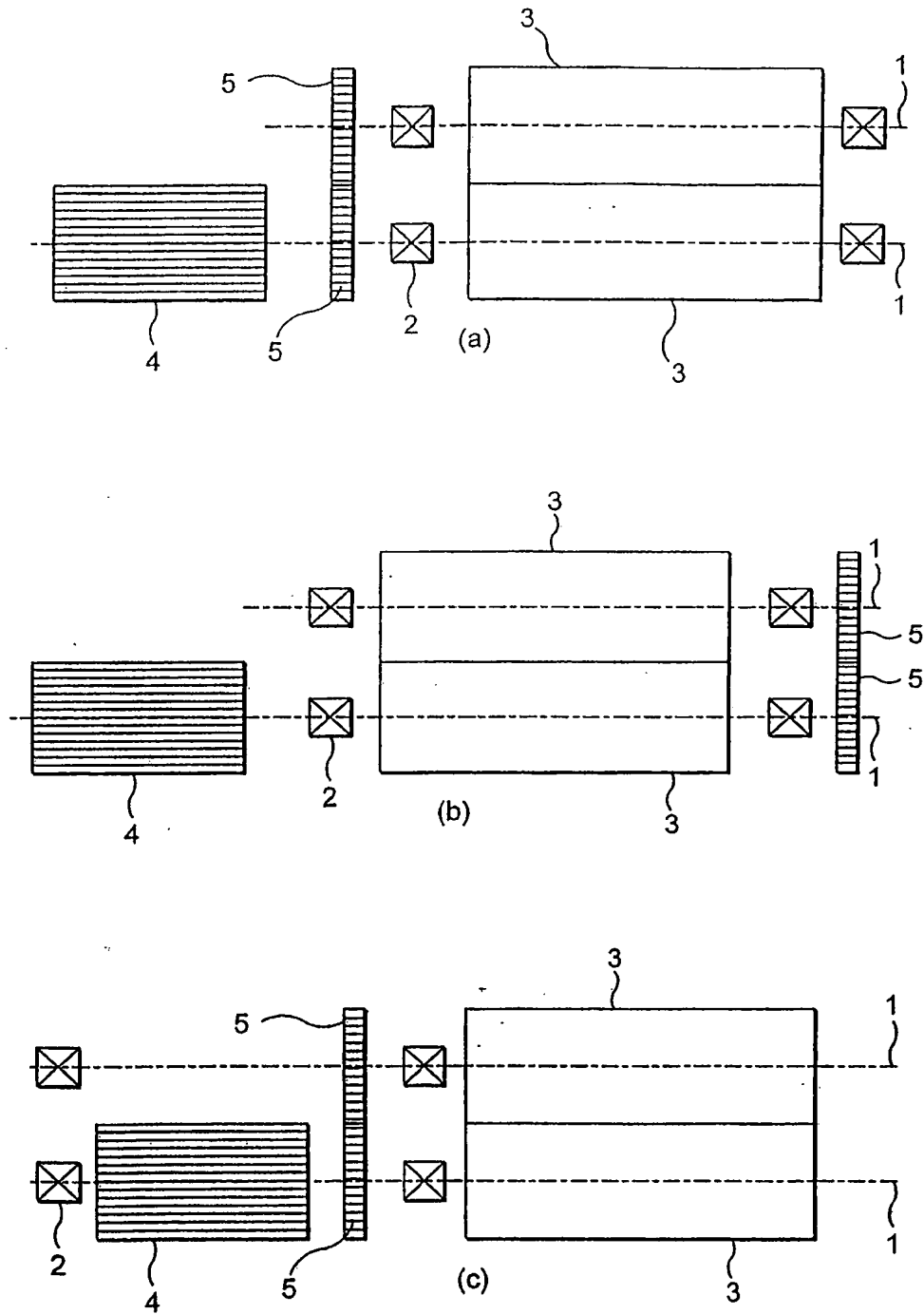
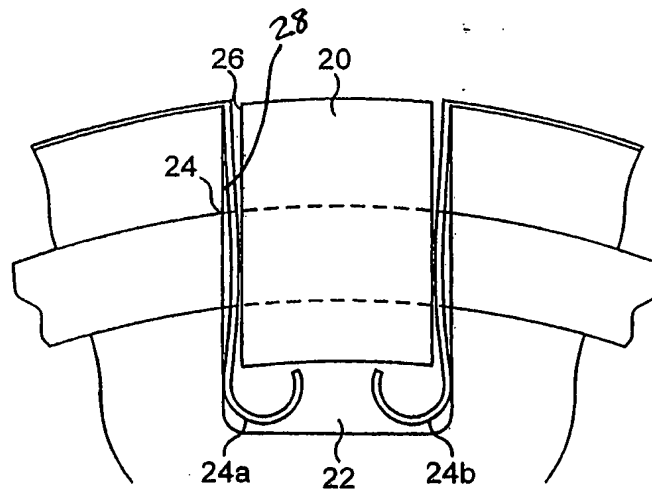
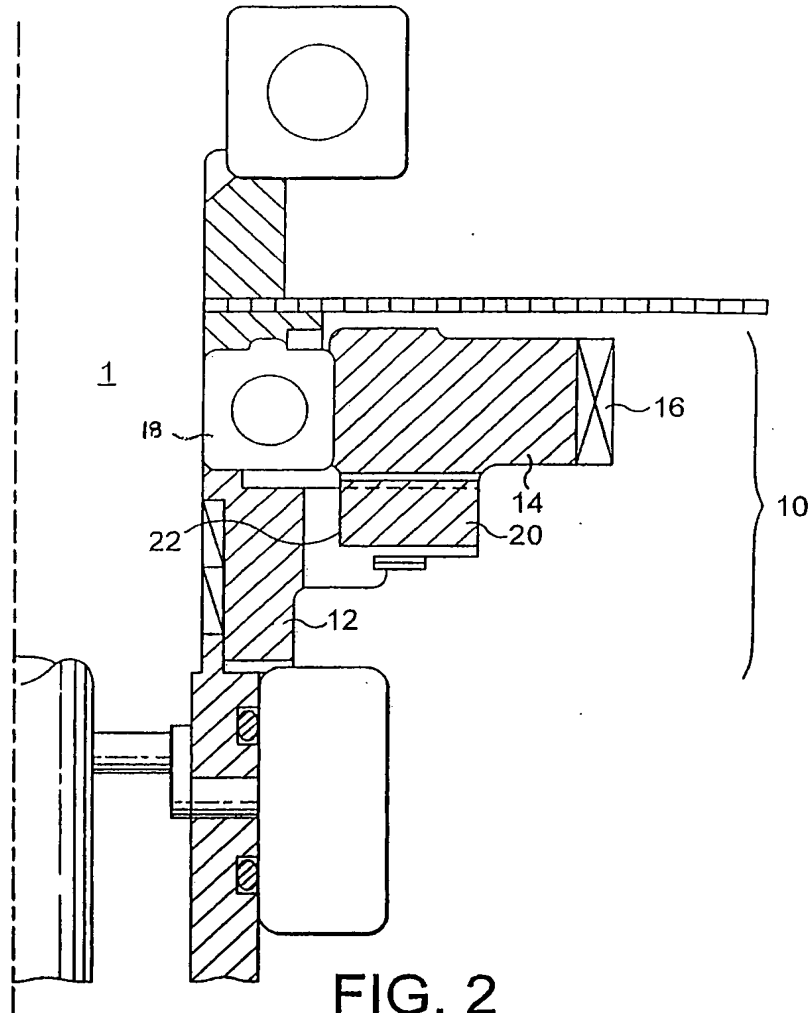


FIG. 1  
(PRIOR ART)

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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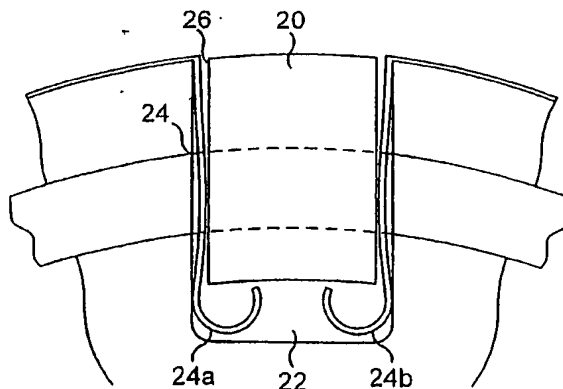
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(54) Title: GEAR ASSEMBLY



(57) Abstract: A gear assembly for transmitting torque from one shaft to another comprises two intermeshing gears mounted on respective shafts. One of the gears comprises a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member. At least one spring provided between the hub member and the annular member has stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

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## GEAR ASSEMBLY

The present invention relates to a gear assembly for transmitting torque from one shaft to another, and to a gear suitable for use in such an assembly. The gear  
5 assembly is particularly useful for transmitting torque between shafts of a vacuum pump.

With reference to Figure 1, a known vacuum pump includes a pumping chamber through which pass a pair of parallel shafts 1 supported by bearings 2. A rotor 3  
10 is mounted on each shaft 1 for rotation within the pumping chamber. The rotors 3 have complementary pumping profiles, which may be Roots, Northey (or "claw") or screw. In use, when a motor 4 is driving one of the shafts 1, the other shaft is rotated synchronously with that shaft by means of the meshed timing gears 5. The rotors 3 are so profiled that fluid to be pumped is drawn into an inlet of the  
15 pumping chamber and exits from the pumping chamber via an outlet.

Figure 1 illustrates three different pumping configurations. In Figure 1(a), the rotors 3 are mounted between the bearings 2 and the timing gears 5 are provided at the motor-driven end of the pump. In Figure 1(b), the timing gears 5 are  
20 provided at the other end of the pump, and Figure 1(c) illustrates a configuration using cantilevered rotors.

Transmission of torque through the meshed gears 5 is affected by gear eccentricity. Gear eccentricity results in an oscillating drive torque, which would  
25 normally be constant with concentric gears. In the case of high inertia, lightly loaded, rotating machinery driven by gears with typical manufacturing eccentricity tolerances, the magnitude of the oscillating drive torque can exceed the steady state drive torque. As a result, the gears leave mesh, which can provoke high frequency tooth-to-tooth slapping, a characteristic noise frequently encountered in  
30 lightly loaded rotating machinery.

- 2 -

Pump design has been improved to reduce friction and power consumption. Consequently the required steady state drive torque has reduced and thus rotating machinery has become increasingly prone to eccentricity induced torsional vibrations and related noise problems.

5

It is an aim of at least the preferred embodiment of the present invention to reduce such torsional vibrations and noise by accommodating typical gear eccentricities.

10

In one aspect, the present invention provides a gear assembly for transmitting torque from one shaft to another, the gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

20

The means for inhibiting torsional vibrations and noise preferably comprises a resilient coupling between the hub member and the annular member. This coupling is preferably located between opposing surfaces of the members. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.

30

The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member.

Alternatively, repelling magnets could be used with the resulting stiffness being  
5 proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled.

10 By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will  
15 leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back  
20 to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

25 This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the  
30 best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention



fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

In another aspect the present invention provides a gear for transmitting torque  
5 from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by the eccentricity of the annular member.

10

A further aspect of the invention provides use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

15 Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates schematically three known pump configurations;

20 Figure 2 is a cross-section of a gear suitable for use in any of the pumps of Figure 1; and

Figure 3 is a cross-section illustrating the mechanism for transmitting torque between the hub member and annular member of the gear of Figure 2.

25

With reference to Figure 2, a gear 10 suitable for use in any of the vacuum pumps shown in Figure 1 or in any other lightly loaded, high inertia rotating machine comprises a hub member 12 for receiving a shaft of the pump and an annular member 14 mounted for rotation with the hub member 12 and having peripheral  
30 teeth 16. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft.

- 5 -

In use, the peripheral teeth 16 of the annular member 14 are in meshing engagement with the corresponding teeth of another gear having a 1:1 gear ratio with the gear 10, similar to the timing gears 5 shown in Figure 1.

5

A drive mechanism for transmitting torque between the members 12, 14 is provided by a plurality of detents provided around a surface perpendicular to the rotational axis of one of the members which enter respective recesses provided around the facing axial surface of the other member. In the embodiment shown in  
10 Figure 2, detents 20 are provided on the annular member 14 and recesses 22 are provided on the hub member 12, although this could be the other way around, with the detents being provided on the hub member and the recesses provided on the annular member.

15 As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially inhibit torsional vibrations and noise induced under lightly loaded conditions by eccentricity of either the annular member 14 or of the gear meshing with the teeth 16 of the annular  
20 member 14. The springs 24a, 24b also provide absorption of any tooth-to-tooth impact resulting from external disturbances.

Under lightly loaded conditions, as experienced by a pump operating at ultimate pressure, the transmission of torque between the members 12, 14 is through one  
25 of the springs 24a, 24b provided within each recess 22. This provides a degree of resilience necessary to accommodate any gear eccentricity.

In the event of the pump being subject to higher loads where a solid drive is needed to avoid compromising the phase relationship between the driving and  
30 driven shafts, the spring flattens between the facing radial surfaces 26, 28 once the angular deflection of the spring has reached a specified value above a

predetermined drive torque. This provides the necessary solid drive between the radial faces 26, 28.

Whilst in this embodiment flat springs have been used to control torsional stiffness, 5 tangentially mounted disc springs or coil springs could be used instead. Alternatively, repelling magnets could be used, with the resulting torsional stiffness being proportional to the magnetic flux. In some applications, use of viscoelastic materials may be appropriate.

CLAIMS

1. A gear assembly for transmitting torque from one shaft to another,  
5 the gear assembly comprising two intermeshing gears mounted on  
respective shafts, one of the gears comprising a hub member for  
receiving one of the shafts, a toothed annular member mounted for  
rotation with the hub member, and means provided between the hub  
member and the annular member having a stiffness capable of  
10 reducing torsional vibrations and noise induced during rotation of the  
gears by the eccentricity of at least one of the gears.
2. A gear assembly according to Claim 1, wherein the means for  
reducing torsional vibrations and noise comprises means for  
15 increasing the critical eccentricity of the gear.
3. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise comprises a  
resilient coupling between the hub member and the annular member.  
20
4. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise is located between  
a radial surface of the hub member and an opposing radial surface of  
the annular member.  
25
5. A gear assembly according to any preceding claim, wherein the  
means for reducing torsional vibrations and noise is located within a  
drive mechanism for transferring torque between the hub member  
and the annular member.  
30
6. A gear assembly according to Claim 5, wherein one of the hub  
member and the annular member comprises a recess for receiving a

- 8 -

detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.

5

7. A gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.  
10
8. A gear assembly according to any preceding claim, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.  
15
9. A gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.  
20
10. A gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.  
25
11. A gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.
- 30 12. A gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.

13. A gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
- 5 14. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
- 10 15. A gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
- 15 16. A vacuum pump comprising at least two shafts connected together by a gear assembly according to any preceding claim.
17. A gear for transmitting torque from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed  
20 annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.
- 25 18. Use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

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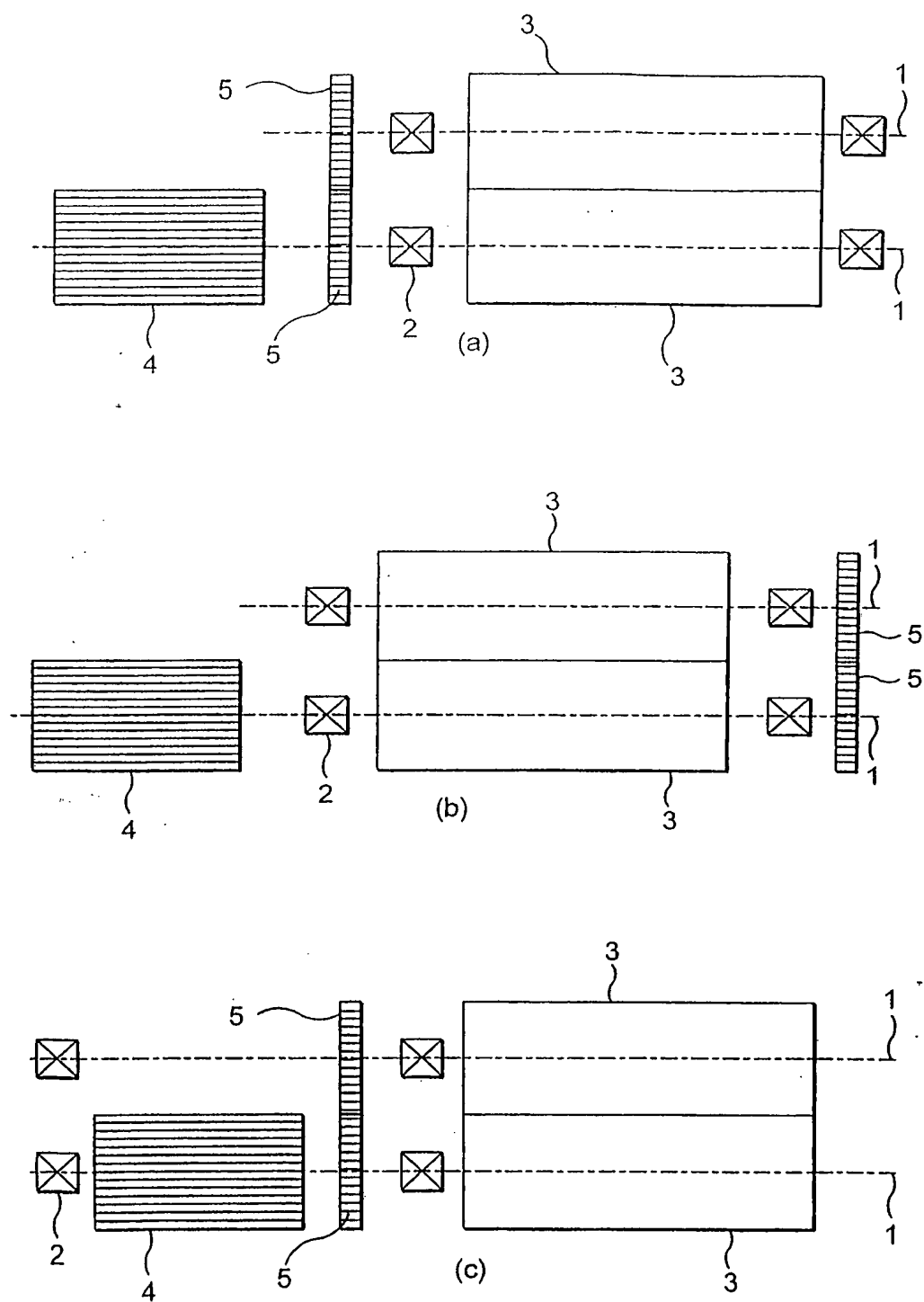


FIG. 1

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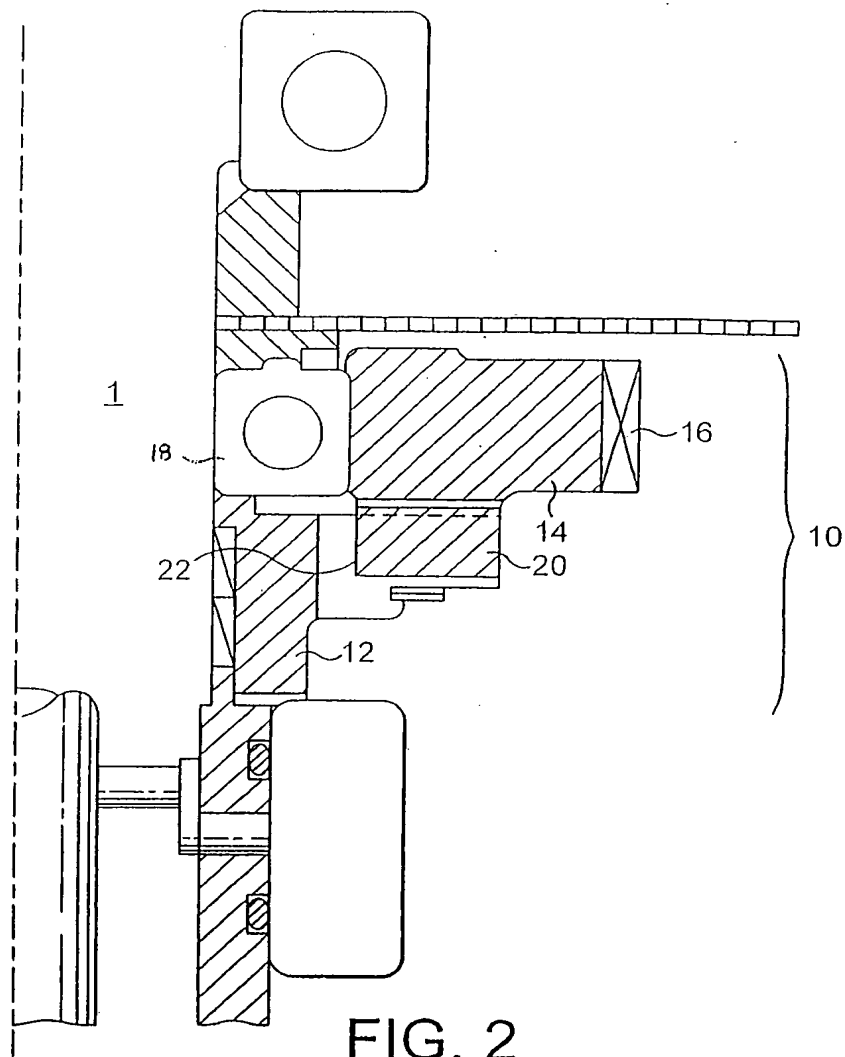


FIG. 2

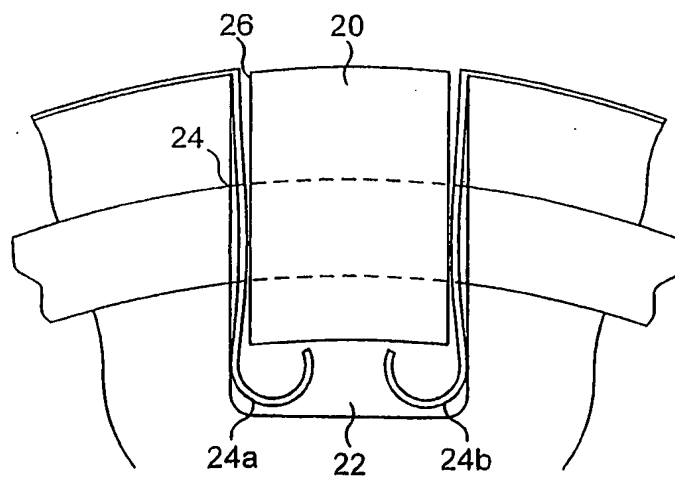


FIG. 3



# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB2005/001087

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 F16H55/14 F16H57/00 F16D3/52 F04C29/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 F16D F16H F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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-/--		

☒ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

10 June 2005

Date of mailing of the international search report

22/06/2005

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Meyer, T

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB2005/001087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International Application No

PCT/GB2005/001087

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US 5893355	A	13-04-1999	NONE	

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INDICATION FORM**

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

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☒ Applicant/Inventor.☐ Assignee of record of the entire interest. See 37 CFR 3.71.  
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)**SIGNATURE of Applicant or Assignee of Record**

Signature

Date

Name

TRISTAN RICHARD GHISLAIN DAVENNE

Telephone

Title and Company

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below\*.

☐ \*Total of \_\_\_\_\_ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**ASSIGNMENT**

**WHEREAS, I/We**, Tristan Richard Ghislain Davenne and John Cambridge Smith, a citizen of/ citizens of the United Kingdom, residing at 15 Chapel Road, Epping, Essex, CM16 5DS, United Kingdom; and Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX, United Kingdom, have invented certain new and useful improvements in GEAR ASSEMBLY for which I/We have made application for Letters Patent of the United States, which application may be identified in the United States Patent and Trademark Office as Serial No. 10/594,260, filed September 25, 2006; which application claims priority from International Application No. PCT/GB2005/001087, filed March 22, 2005; and,

**WHEREAS, Edwards Limited**, an English Company of Manor Royal, Crawley, West Sussex, RH10 9LW, United Kingdom, is desirous of obtaining the entire right, title and interest in, to and under the said improvements and the said application:

**NOW, THEREFORE**, in consideration of the sum of One Dollar (\$1.00) to me/us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, I/WE, the said Tristan Richard Ghislain Davenne and John Cambridge Smith have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said **Edwards Limited**, its successors, legal representatives and assigns, the entire right, title and interest in, to and under the invention, the said improvements, and the said application, all applications derived therefrom and all continuing prosecution applications, conversions, divisions, renewals and continuations thereof, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof, and all applications for Letters Patent or Inventor's Certificates which may hereafter be filed for said improvements in any country or countries foreign to the United States, and all Letters Patent or Inventor's Certificates which may be granted for said improvements in any country or countries foreign to the United States and all extensions, renewals and reissues thereof; and I/We hereby authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all Letters Patent for said improvements to the said **Edwards Limited**, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

**I/WE HEREBY** covenant that I/We have full right to convey the entire interest herein assigned, and that I/WE have not executed, and will not execute, any agreement in conflict herewith.

**AND I/WE HEREBY** further covenant and agree that I/We will communicate to the said **Edwards Limited**, its successors, legal representatives and assigns, any facts known to me/us respecting said invention and said improvements, and testify in any legal proceeding, sign all lawful papers, execute all continuing prosecution, divisional, continuing, reexamination and reissue applications, make all rightful oaths, and generally do everything possible to aid the said **Edwards Limited**, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said inventions and improvements in all countries.

<u>Date</u>	<u>Assignor</u>	<u>Witnessed By:</u>
<hr/>	<hr/> Tristan Richard Ghislain Davenne	<hr/> At: <hr/>
<hr/>	<hr/> John Cambridge Smith	<hr/> At: <hr/>




## Track results detail

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### Tracking results detail for 7407809953

#### Tracking summary

Current Status  **Shipment delivered.**

Delivered on 10/11/2007 10:46 am

Delivered to

Signed for by **DAVENNE**

#### Tracking history

Date and Time	Status	Location
10/11/2007 10:46 am	Shipment delivered.	Gatwick, United Kingdom
8:39 am	With delivery courier.	Gatwick, United Kingdom
3:49 am	Depart Facility	East Midlands, United Kingdom
10/10/2007 6:37 pm	Transit through DHL facility	East Midlands, United Kingdom
7:05 am	Depart Facility	Wilmington - Clinton Field, OH
2:46 am	In transit.	Wilmington - Clinton Field, OH
2:43 am	In transit.	Wilmington - Clinton Field, OH
10/9/2007 10:15 pm	Shipment picked up	Parsippany, NJ
9:36 pm	Departing origin.	Parsippany, NJ

Ship From: BOC EDWARDS INC Morristown, NJ 07960 United States	Ship To: Epping Essex, United Kingdom	Shipment Information: Ship date: 10/9/2007 Pieces: 1 Total weight: 3 lbs *
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Attention: BOC EDWARDS INC	Attention:	Ship Type: Shipment Reference: CC17007518 Service: Express Special Service: Description: DOCS
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Morristown, NJ 07960  
USA

Tel: +1 973 285 3309  
In USA: +1 800 848 9800  
Fax: +1 973 285 3320

VIA DHL

October 22, 2007

Mr. Tristan Richard Ghislain Davenne  
15 Chapel Road  
Epping  
Essex CM16 5DS  
United Kingdom

RE: U.S. Patent Application No. 10/594,260  
Filing Date: September 25, 2006  
Title: GEAR ASSEMBLY  
Dkt. No. M04B101

Dear Mr. Davenne:

Pursuant to my October 9, 2007 letter, please be reminded that we have not yet received back from you the declaration, assignment, and power of attorney documents relating to the subject patent application. Please execute the forms as soon as possible and return them to me by no later than **October 24, 2007**.

Please contact me as soon as possible.

Thank you again for your immediate attention to this matter.

Best Regards,

Kristi Nicholes | Patent Agent | Edwards  
Tel: 1 973 285 3309 | Mobile: 1 862 812 4944 | [kristi.nicholes@edwardsvacuum.com](mailto:kristi.nicholes@edwardsvacuum.com)

MKN:bjl



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Payer Account No.

Shipment Value Protection (see reverse)

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☐ Check  
☐ Credit CardNot all payment  
options are available  
in all countries.**2 From (Shipper)**

Shipper's Account Number

802404455

Contact Name

Betty Lee

Shipper's Reference (up to 35 characters)

M04B101

Company Name

BOC EDWARDS, INC

Address

STE 400  
55 MADISON AVE  
MORRISTOWN NJ

Post/ZIP Code (required)

079607337

Phone, Fax, or E-mail (required)

973 285 3314

**3 To (Receiver)**

Company Name

Contact Person

Mr. Tristan Richard Ghislain Davenne

Delivery Address DHL Cannot Deliver to a PO Box

15 Chapel Road  
Epping  
Essex

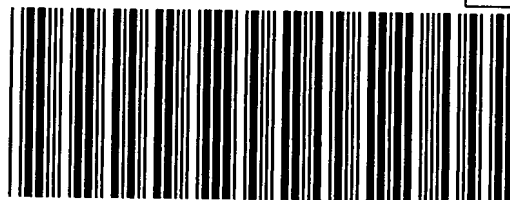
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7407809032

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Export License No./Symbol (if applicable) Receiver's VAT/GST or Shipper's EIN/SSN

Declared Value for Customs (in US \$)  
(as on commercial/proforma invoice)

Schedule B Number / Harmonized Code (if applicable)

AES TRANSACTION NUMBER

TYPE OF EXPORT

☐ Permanent ☐ Repair/Return ☐ Temporary

Destination Duties/Taxes If left blank, Receiver pays duties/taxes.

☐ Receiver ☐ Shipper ☐ Other

Specify approved account number

The commodities, technology or software to be exported from the U.S. are in compliance with the U.S. Bureau of Export Administration. Diversion to countries contrary to U.S. law prohibited.

**7 Shipper's Authorization (signature required)**

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Signature (required) Betty Lee

Date 10/22/07

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Type

Expires

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Route No.

Time

Date

DHL Express (USA), Inc., 1200 South Pine Island Road, Plantation, Florida 33324

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## Track results detail

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### Tracking results detail for 7407809032

#### Tracking summary

Current Status  **Shipment delivered.**

Delivered on 10/24/2007 11:12 am

Delivered to

Signed for by **DAVENNE**

#### Tracking history

Date and Time	Status	Location
10/24/2007 11:12 am	Shipment delivered.	Gatwick, United Kingdom
8:43 am	With delivery courier.	Gatwick, United Kingdom
6:51 am	Arrived at DHL facility.	Gatwick, United Kingdom
3:47 am	Depart Facility	East Midlands, United Kingdom
10/23/2007 7:05 am	Depart Facility	Wilmington - Clinton Field, OH
2:19 am	In transit.	Wilmington - Clinton Field, OH
10/22/2007 8:58 pm	Departing origin.	Parsippany, NJ
7:38 pm	Shipment picked up	Parsippany, NJ
Ship From: BOC EDWARDS INC Morristown, NJ 07960 United States	Ship To: Epping Essex, United Kingdom	Shipment Information: Ship date: 10/22/2007 Pieces: 1 Total weight: 1 lb *
Attention: BOC EDWARDS INC	Attention:	Ship Type: Shipment Reference: M04B101 Service: Express Special Service: Description: DOCS

Tracking detail provided by DHL: 10/24/2007, 5:59:12 am pt.

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RECEIVED

OCT 22 2007

By: B.lee  
EDWARDS VACUUM, INC.  
Intellectual Property

Tristan Davenne  
c/o BOC Edwards  
Unit 2  
Dolphin Road  
Shoreham By Sea  
West Sussex  
BN43 6RH

Our Ref. M048101US/ASB      Phone +44.1276.807537      Fax +44.1276.807785      E-mail [Cathy.Kelly@boc.com](mailto:Cathy.Kelly@boc.com)

Date  
8 November 2006

**US PATENT APPLICATION NO. 10/594,260  
ENTITLED GEAR ASSEMBLY  
THE BOC GROUP plc**

Dear Tristan,

The above mentioned patent application for which you are a named inventor has been filed in the United States of America. Ira Zebrak who is a US Patent Attorney at our site in Murray Hill has asked me to obtain your signature for assignment and declaration documents so this application can proceed in the United States.

Please sign the documents and return to me at the below address in the envelope provided and I will forward them back to Ira Zebrak after I have obtained the other inventors signatures.

Please do not hesitate to contact me should you have any queries.

Yours sincerely

**Cathy Kelly**  
Intellectual Property Formalities Administrator  
Legal Services

Linde and The BOC Group have merged to become The Linde Group. For further information please visit [www.linde.com](http://www.linde.com)

The BOC Group plc. Registered Office: Cherisey Road, Windlesham, Surrey GU20 6HJ, England. Number 22096-English Register  
For postal deliveries please use the following details:  
The BOC Group plc., Cherisey Road, Windlesham, Surrey GU20 6HJ  
Phone: +44.1276.477222, Fax: +44.1276.471333



RECEIVED

OCT 22 2007

By: B. Lee  
EDWARDS VACUUM, INC.  
Intellectual Property

Tristan Davenne  
5 Adelaide Square  
Shoreham-by-Sea  
West Sussex  
BN43 6LN

Our Ref.  
M04B101US/ASB

Phone  
+44.1276.807612

Fax  
+44.1276.807785

E-mail  
[Cathy.Kelly@boc.com](mailto:Cathy.Kelly@boc.com)

Date  
22 November 2006

**US PATENT APPLICATION ENTITLED GEAR ASSEMBLY – SERIAL NO. 10/594,260**  
**THE BOC GROUP, plc**

Dear Tristan,

The above mentioned patent application for which you are a named inventor has been filed in the United States of America. Ira Zebrak who is a US Patent Attorney at our site in Murray Hill has asked me to obtain your signature for assignment and declaration documents so this application can proceed in the United States.

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Yours sincerely

Cathy Kelly  
Intellectual Property Formalities Administrator  
Legal Services

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OCT 22 2007

By: B. Lee  
EDWARDS VACUUM, INC.  
Intellectual Property

Tristan Davenne  
5 Adelaide Square  
Shoreham by Sea  
West Sussex  
BN43 6LN

Our Ref.  
M04B101US/ASB

Phone  
+44.1276.807537

Fax  
+44.1276.807785

E-mail  
[Cathy.Kelly@boc.com](mailto:Cathy.Kelly@boc.com)

Date  
20 December 2006

**US PATENT APPLICATION NO. 10/594,260 ENTITLED GEAR ASSEMBLY  
THE BOC GROUP plc**

Dear Tristan,

The above mentioned patent application for which you are a named inventor has been filed in the United States of America. Ira Zebrak who is a US Patent Attorney at our site in Murray Hill has asked me to obtain your signature for assignment and declaration documents so this application can proceed in the United States.

Please sign the documents and return to me at the below address in the envelope provided and I will forward them back to Ira Zebrak after I have obtained the other inventors signatures.

This matter is now urgent. If there is a problem with signing these documents please could you contact me ASAP. If you have already signed and returned the documents to me please could you contact me and let me know when they were sent.

Please do not hesitate to contact me should you have any queries.

Kind regards

Cathy Kelly  
Intellectual Property Formalities Administrator  
Legal Services

Linde and The BOC Group have merged to become The Linde Group. For further information please visit [www.linde.com](http://www.linde.com).

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**Nicholes, Kristi**

---

**From:** Tribe, Julia  
**Sent:** Friday, May 11, 2007 10:06 AM  
**To:** Lee, Betty  
**Cc:** Booth, Andy-WIN  
**Subject:** RE: M04B101

Dear Betty

I have made some enquiries into this matter and have found the documents as signed by John Smith on file. These documents were given to Tristan Davenne for completion prior to his departure from BOC, but he refused to sign them and left them on his desk upon departure. We have no forwarding address for him and have been unable to trace his whereabouts. We therefore believe we have made every reasonable endeavour to contact him.

In light of this, could you please prepare the necessary documents for dealing with such occurrences. In the meantime, please confirm whether or not you would like me to return the documents that have been signed by John Smith.

Many thanks - have a good weekend.

Regards

*Julia*

**Legal Services**

**The Linde Group**

phone: +44.1276.807692

fax: +44.1276.807785

Visit us at - [http://bocweb13.group.boc.com/legal\\_global/intellectual\\_property/index.asp](http://bocweb13.group.boc.com/legal_global/intellectual_property/index.asp)  
or - [http://145.225.250.14/legal\\_global/](http://145.225.250.14/legal_global/)

-----Original Message-----

**From:** Lee, Betty  
**Sent:** 10 May 2007 20:17  
**To:** Booth, Andy-WIN  
**Cc:** Tribe, Julia  
**Subject:** M04B101  
**Importance:** High

Dear Andy:

Pursuant to Ira's **November 7, 2006**, memo, we have not yet received back from you the signed declaration, assignment, and power of attorney forms for the subject case.

If you did not receive the documents, we will re-send.

Thank you.

Regards,  
Betty

*Betty Lee*

**Legal Services**

**The Linde Group**

phone: +1.908.771.6481

Visit us at - [http://bocweb13.group.boc.com/legal\\_global/intellectual\\_property/index.asp](http://bocweb13.group.boc.com/legal_global/intellectual_property/index.asp)